A MANUAL OF SURGERY

For Students and Practitioners

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TO

LORD LISTER, LL.D., F.R.S.,

President of the Royal Society,

THE FATHER OF ANTISEPTIC SURGERY,

THIS WORK IS, WITH PERMISSION,

Dedicated by the Authors,

IN GRATEFUL ACKNOWLEDGMENT OF THE MANY ADVANTAGES

THEY HAVE DERIVED

WHILST ASSOCIATED WITH HIM IN HIS WORK

AT KING'S COLLEGE HOSPITAL.

PREFACE

In preparing this manual of surgery for the profession, we have endeavoured to meet what we think is at the present time a genuine need. The many large and valuable text-books and works of reference already in existence are almost more than the ordinary student can master during the time at his disposal. It has therefore been our aim to present the facts of surgical science in a concise and succinct form, so as to satisfy the needs of the student, even of those who are preparing for the higher examinations. At the same time, the requirements of the general practitioner have not been overlooked, for we have taken care to discuss in detail those conditions which are most likely to be met with in ordinary practice. The main difficulty has been to compress into a small space the ever-increasing amount of material available, so that we have only been able to sketch in outline much that could have been elaborately described did the size of the book permit. For the same reason, historical and bibliographical references have to a large extent been omitted, whilst diseases of special regions—such as the eye, ear, and female genital organs—are also practically excluded, except in so far as they encroach on the domains of general surgery. The progress of bacteriology and the influence of antisepsis have so transformed the characters and extended the scope of surgical work that many of the traditions and theories of the past have had to be discarded, although at the same time we have endeavoured to preserve and respect that which has been shown to be good and useful in the laborious researches and accumulated experiences of bygone generations.

In conclusion, our best thanks are due to Dr. St. Clair Thomson, who has kindly looked through the proofs of the sections devoted to the nose and ear; to Dr. Silk, who has fulfilled a similar office in reference to the chapter on anæsthetics; to Mr. William Turner for preparing the index; and to Dr. Arthur Griffiths, late of the Bristol General Hospital, who has drawn several of the pictures, and given other valuable assistance.

Many of the illustrations have been specially prepared for this work, but we have also to acknowledge the loan of blocks from Messrs. Veit and Co., of Leipzig; from Messrs. Cassell and Co., J. and A. Churchill, Longman and Co.; and from the editors of the *Lancet* for the loan of Fig. 287. The various sources from which these are derived are acknowledged throughout the book. Illustrations of instruments are mainly derived from Messrs. Down Brothers, who have kindly placed them at our disposal.

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CONTENTS

ERRATA.

Page 152, line 15, *for* 'Fig. 231' *read* 'Fig. 243.'
Page 426, line 3, *for* 'impacted' *read* 'broken off or impacted.'
Page 456, line 30, *for* 'antiseptia' *read* 'antiseptic.'
Page 456, line 31, *for* 'by c' *read* 'by a.'
Page 514, line 20 from bottom, *for* 'vesicle' *read* 'vesical.'
Page 547, line 10 from bottom, *add* 'of' *after* 'enlargement.'
Page 687, line 12 from bottom, *for* 'Lünenberg' *read* 'Löwenberg.'
Page 693, line 27 from bottom, *insert* 'nose and' *before* 'naso-pharynx.'
Page 1034, line 3 from bottom, *for* 'pubic' *read* 'pudic.'

XIV. INJURIES OF BONES—FRACTURES
XV. INJURIES OF JOINTS—DISLOCATIONS - - 428
XVI. HEAD INJURIES - - - - - 460
XVII. INJURIES OF THE SPINE - - - - 499
XVIII. DISEASES OF BONE - - - - - 517
XIX. DISEASES OF JOINTS—EXCISIONS - - - 556
XX. DEFORMITIES - - - - - 606
XXI. AFFECTIONS OF THE SCALP, CRANIUM, AND CRANIAL CONTENTS - - - - - - 641
XXII. AFFECTIONS OF THE FACE, LIPS, AND JAWS - 652

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CONTENTS

CHAPTER PAGE

I. INFLAMMATION—BACTERIA - - - - 9
II. SUPPURATION, ACUTE AND CHRONIC - - 34
III. ULCERATION - - - - - - 52
IV. GANGRENE - - - - - 63
V. SEPSIS AND INFECTION - - - - 89
VI. TUMOURS AND CYSTS - - - - 133
VII. WOUNDS - - - - - - 173
VIII. HÆMORRHAGE - - - - - 210
IX. INJURIES AND DISEASES OF ARTERIES—ANEURISM—LIGATURE OF VESSELS - - - - 235
X. AFFECTIONS OF VEINS - - - - 290
XI. DISEASES OF LYMPHATIC VESSELS AND GLANDS - 305
XII. AFFECTIONS OF NERVES—OPERATIONS, ETC., ON SPECIAL NERVES - - - - - 318
XIII. AFFECTIONS OF MUSCLES, TENDONS, AND BURSÆ - 344
XIV. INJURIES OF BONES—FRACTURES - - - 357
XV. INJURIES OF JOINTS—DISLOCATIONS - - 428
XVI. HEAD INJURIES - - - - - 460
XVII. INJURIES OF THE SPINE - - - - 499
XVIII. DISEASES OF BONE - - - - - 517
XIX. DISEASES OF JOINTS—EXCISIONS - - - 556
XX. DEFORMITIES - - - - - 606
XXI. AFFECTIONS OF THE SCALP, CRANIUM, AND CRANIAL CONTENTS - - - - - - 641
XXII. AFFECTIONS OF THE FACE, LIPS, AND JAWS - 652

CHAPTER PAGE
XXIII. AFFECTIONS OF THE NOSE AND NASO-PHARYNX - 681
XXIV. AFFECTIONS OF THE MOUTH, TONGUE, THROAT, AND ŒSOPHAGUS - - - - - 699
XXV. DISEASES OF THE EAR - - - - 739
XXVI. SURGERY OF THE NECK - - - - 748
XXVII. SURGERY OF THE AIR-PASSAGES, LUNGS, AND CHEST 763
XXVIII. DISEASES OF THE BREAST - - - - 791
XXIX. DISEASES OF THE SPINE - - - - 812
XXX. ABDOMINAL SURGERY - - - - 833
XXXI. HERNIA - - - - - - 905
XXXII. INTESTINAL OBSTRUCTION - - - - 942
XXXIII. AFFECTIONS OF THE RECTUM AND ANUS - - 958
XXXIV. SURGICAL AFFECTIONS OF THE KIDNEYS - - 982
XXXV. SURGERY OF THE BLADDER AND PROSTATE - - 1003
XXXVI. AFFECTIONS OF THE URETHRA AND PENIS - - 1048
XXXVII. AFFECTIONS OF THE TESTIS, CORD, SCROTUM, AND SEMINAL VESICLES - - - - 1069
XXXVIII. VENEREAL DISEASES - - - - 1093
XXXIX. PLASTIC SURGERY - - - - - 1117
XL. AMPUTATIONS - - - - - 1121
XLI. ANÆSTHESIA - - - - - 1139
INDEX - - - - - - 1145

PAGE
681
699
739
748
763
791
812
833
905
942
958
982
1003
1048
1069
1093
1117
1121
1139
1145

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CHAPTER I.

INFLAMMATION.

'INFLAMMATION is the succession of changes which occur in a living tissue when it is injured, providing the injury is not of such a degree as to at once destroy its structure and vitality.' Such was the definition given in 1870 by Dr. Burdon Sanderson, and no better has yet been devised, although it is now necessary to amplify the term 'injury' to include bacterial invasion, the commonest cause of the inflammatory process. Formerly inflammation was looked on by pathologists as always of a destructive and harmful nature, but at the present time bacteriological research has demonstrated that it is often rather of a protective or conservative character, being Nature's means of limiting the advance of noxious micro-organisms, and of finally eliminating them from the system. Many theories as to the exact nature of the process have arisen from time to time, and even at the present day opinions on the subject are much divided. Thus, formerly it was considered to be a 'perversion of the natural acts of nutrition of the part,' accompanied by an increased amount of tissue activity and cell-proliferation; but it has been clearly shown by Lister, Cohnheim, and other observers, to be in reality associated with a condition of diminished vitality of the part whereby the living tissue is in danger of destruction, or of such changes as will render it incapable of again maintaining its old functions. Then, again, some would look on it as a primarily nervous phenomenon, the injury to the peripheral nerves leading either to vascular spasm or relaxation, whilst others claim that the cells of the inflamed area are first affected. The most recent communications on this subject are rather in favour of the idea that the primary lesion is one of the vascular walls, and would look on inflammation as a disturbance of the equilibrium normally maintained between the vessel walls and the vessel contents, whereby the latter are enabled to escape into the perivascular tissues, and there produce the clinical effects so commonly seen.

The actual *phenomena* of inflammation may perhaps best be studied in the web of a frog's foot. If this is spread out and examined under the microscope, the following evidences of physiological activity may be seen: (*a*) the flow of blood through the vessels, as indicated by the movement of the corpuscles, the red ones, each separate from the other, flowing in the central or axial current, the leucocytes only occasionally seen amongst the red, or here and there one may be noticed rolling lazily along in the inert corpuscle-free peripheral portion of the tube; (*b*) the constant changes in calibre of the arterioles independent of the heart's rhythmical action, and influencing in a marked degree the flow through the capillaries; and (*c*) the changes which occur in the pigment-cells, which represent the connective tissues of the part. These are mainly due to the influence of light, the cells contracting or expanding as the light is increased or diminished.

If now a crystal of common salt, or some such irritant, is applied to the web, the early vascular phenomena contributing to inflammation may be readily observed.

I.—The Vascular Changes in Acute Inflammation.

A momentary contraction may perhaps be noticed in the arterioles of the part, but this is only apparent in inflammations produced artificially, and is of no known significance. It is followed by a condition of **Hyperæmia** of the inflamed area, as manifested by a rapid and lasting dilatation of the vessels, accompanied by an increase in the rapidity of the blood-flow (*acceleration*). This is a peculiarly vital phenomenon, and opposed to the hydrostatic law that when fluid is flowing through a tube or channel at a fixed pressure, if the lumen is suddenly widened, the rate of the blood-flow is diminished. This increased rapidity of the flow lasts for a while, and then the current gradually becomes slower and slower (*retardation*), as if an ever-growing obstruction existed to the passage of the blood; then a period of *oscillation* will be noticed, the blood-current swaying forwards and backwards, and finally a condition of *stasis* or still-stand is arrived at, which may or may not end in actual *thrombosis* or intravascular coagulation. During this period considerable changes have occurred in the behaviour and condition of the vessel contents. Thus, almost as soon as the dilatation of the vessels occurs, the leucocytes tend to collect along the walls in the peripheral inert layer, seeming, as it were, to fall out of rank. This process first commences in the veins, but can be observed in all the vessels. The red corpuscles also, which formerly had flowed along separately, now tend to adhere to each other, and to the vessel walls, running into rouleaux.

The second factor in the vascular changes must now be considered, viz., **Exudation**, a proceeding which becomes evident at a very early stage. Every element in the constitution of the blood participates in this process. The *leucocytes* are the first to pass through the vessel walls, especially those of the smaller veins and capillaries. The process is a strictly vital one, brought about by amœboid movement ; a small arm or outgrowth of the leucocyte (*pseudopodium*) is inserted between the endothelial cells lining the vessel, whose cohesion has been probably interfered with by the inflammatory process. Into this arm the protoplasm of the leucocyte flows, still further separating the endothelial elements, and thus the cell passes through the wall into the connective tissues without (Fig. 1). Arnold described definite openings or stomata in the endothelial coat of the vessels, through which he thought the leucocytes passed; but further investigations have not confirmed this observation. When once the white corpuscle has migrated into the peri-vascular tissues, it may undergo various changes which have only recently been clearly made out. Thus,

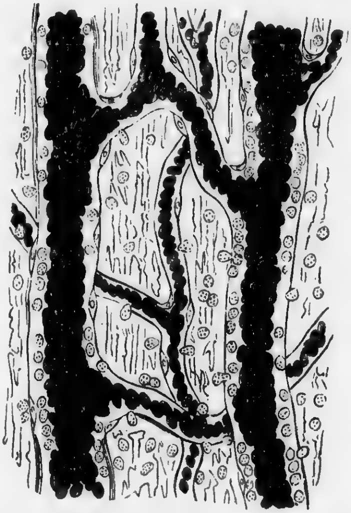

FIG. 1.—DIAGRAMMATIC REPRESENTATION OF THE VASCULAR PHENOMENA OF INFLAMMATION. (AFTER KEEN AND WHITE.)

Two thin-walled venules are seen, and several capillaries. The red corpuscles are still occupying the axial portion of the tubes, whilst the periphery is crowded with leucocytes, which in several places are in process of migration into the surrounding cellular tissue.

it may die or be broken up at once, setting free fibrin ferment, and assist in the production of the inflammatory coagulum to be shortly described; or, again, it may serve as pabulum for the larger fibroblastic cells which soon make their appearance, arising apparently from the multiplication of the connective-tissue corpuscles in the neighbourhood; or, once more, some of the exuded cells are likely to find their way back again into the circulation through the lymphatics, and others may be transformed into pus corpuscles; whilst still many of them prior either to disintegration or transformation into pus corpuscles have a function to fulfil in attacking and removing any dead tissue which may exist in the neighbourhood of the inflammatory focus, whilst a phagocytic function (*i.e.*, microbe-destroying, *vide* p. 17) is also subserved by them. In fact, the leucocytes may be looked on as the scavengers of the body, or as advanced guards, which, at the first onset of mischief, are thrown out from the vessels as Nature's first line of defence against the invading forces, their chief duty being to remove all damaged and noxious materials, and then, having limited the spread of the destructive process, they in turn give place to the larger and more useful fibroblastic cells which are the active agents in the process of repair.

The *red corpuscles* pass through the walls of the capillaries by a process of diapedesis, the result of simple mechanical pressure; this usually only occurs in very acute attacks. When once external to the vessels they are broken up and their colouring matter diffused abroad, and no further part is known to be played by them.

The *liquor sanguinis* is also extravasated. This is merely an exaggeration of a normal process, although usually the lymphatics are fully capable of removing all the fluid exuded. In pathological conditions the amount of plasma which passes through the walls is excessive, and although for a time the lymphatics of an inflamed region do increased work, yet the transudation is soon greater than they can deal with. If the fluid escapes into the tissues, it undergoes coagulation by meeting the necessary coagulating media developed from the breaking-down leucocytes; *inflammatory lymph* forms locally, whilst the *serum* collects in the meshes of the tissues, constituting an inflammatory form of œdema; if there is a sufficient breach of surface, the serum drains away. If the exudation take place from a serous surface—*e.g.*, pleura, peritoneum, synovial membrane, etc.—the fluid passes into and distends the cavity; it is at first spontaneously coagulable, but sooner or later coagulation is likely to occur, and then the clot or lymph either forms an adherent plastic mass on the surface or floats free in the fluid.

Looked at, then, simply from a vascular point of view,

Inflammation = Hyperæmia + Exudation.

In addition, however, to these vascular phenomena, which can readily be observed in a frog's web, there are others which cannot be so easily observed, and which may be described as

II.—The Tissue Changes in Inflammation.

Great differences in opinion have been in existence as to the part played by the tissues in inflammation ; but although there may still be points to be elucidated, yet the general opinion of pathologists is at the present day tolerably well defined. Formerly, in accord with Virchow's cellular pathology, it was held that the tissues were the all-important element, and that the immense number of cells which collect in an inflamed area was entirely due to the proliferation of the connective-tissue corpuscles. Lister, as far back as 1858, maintained the passive condition of the tissues; and when Cohnheim, in 1867, described the migration of the leucocytes, everything in the process of inflammation was attributed to them. Since that date Senftleben and many other observers have worked at the same problem, and a considerable amount of fresh light has been thrown on the subject by experiments consisting in the insertion of foreign bodies into the peritoneal cavity, and by others directed towards demonstrating the phagocytic functions of leucocytes and the influence of chemiotaxis (p. 18). Much of the difficulty which has enshrouded the question has arisen from a confusion between the processes of inflammation and repair. At one time repair was always looked on as of an inflammatory nature ; but it is evident that although no lesion in the body can occur without a certain amount of inflammatory reaction, yet the true process of repair cannot be of that nature. Again, it is important to differentiate between the changes which occur in acute and chronic forms of inflammation, and between those met with in superficial and deep parts ; whilst the bacterial origin or not of the process must also be taken into account.

In acute inflammation there can now be no question that the primary effect on the tissues, at any rate in inflammations due to bacterial activity, is to paralyze them ; they become infiltrated with leucocytes, and with the products of exudation and of microbic multiplication, the protoplasm within the cells coagulating and refusing to take up the ordinary stains, constituting a condition known as **Coagulation Necrosis.** This necrotic tissue is in time absorbed entirely by the leucocytes, or is liquefied by the peptonizing activity of the bacterial toxines, so that it is replaced by a mass of small round cells, nourished by the fluids transuding through them, and sometimes known as **Embryonic Tissue.** According to the relative vitality and vigour of the individual and the bacteria, this mass may in turn either be replaced by larger round cells derived from the connective tissues (*fibroblasts*), by means of which most of the leucocytes are absorbed, and repair is brought about; or the whole mass may be liquefied and break down into pus. In non-bacterial inflammations of superficial parts the amount of effusion between the individual cells may be so excessive as to separate and disintegrate them, and thus **Colliquative Necrosis** may be induced, as occurs in the formation of blisters after a burn. Once more, acute inflammation of mucous membranes may be associated with active proliferation of the surface epithelium, as in catarrhal and gonorrhœal affections.

In chronic inflammations, on the other hand, active cell proliferation is a most important element in the process, resulting in sclerosis and induration of the parts. This, however, mainly affects the interstitial tissues, and thus the true structure of the organ may be impaired, whilst the connective tissue increases in amount.

Terminations of Acute Inflammation.

These vary according to the cause of the mischief and the intensity of the process. They may be described under five distinct headings:

1. **Resolution**, or the restoration of the part to its natural condition and function. This can only occur when the injury has not been so severe as to destroy the vitality of the affected tissues, and when the vascular changes have not gone further than stasis. When once thrombosis has occurred in a vessel, the parts can never be restored to the *status quo ante*. The phenomena of resolution will be merely those of inflammation in a retrograde order—viz., an oscillatory movement will first manifest itself amongst the corpuscles, and gradually the blood-stream will be restored, slowly at first, and more and more rapidly afterwards. The adhesiveness of the corpuscles will disappear by degrees, and it will be some time before the peripheral inert layer can be seen. The exuded leucocytes find their way back into the circulation either through the vessel walls, or to a greater extent *viâ* the lymphatics, or else they may be disintegrated in the tissues and absorbed. The fluid exudation will be removed by the lymphatics. For some time after an acute attack the vessels of the part remain somewhat dilated from simple loss of tone, but this also gradually disappears.

2. **Organization, or Fibroid Thickening,** occurs when the inflammatory process is not arrested until after the occurrence of thrombosis, but has stopped short of suppuration. The parts under these circumstances cannot be restored to their original condition, but changes take place in the cellulo-plastic exudation and in the connective tissue around, which result in its transformation into cicatricial tissue, and hence the details of the process will be similar to those described under the heading of 'Repair of Wounds' (Chapter VII.).

3. **Suppuration** is always due to the invasion of the affected region by certain pyogenic organisms, which act in such a manner as to disintegrate and liquefy not only the tissues involved, but also in part the exudation (Chapter II.).

4. **Ulceration** is produced by the action on the surface of either skin or mucous membrane of an irritant of such nature and intensity as to destroy its vitality, though without evident sloughing (Chapter III.).

5. **Gangrene** is a less common result of inflammation, and is due either to the activity of the virus or the weakness of the tissues attacked (Chapter IV.)

Clinical Signs of Inflammation.

These may for practical purposes be described under the four headings given of old by Celsus, viz., heat, pain, redness, and swelling, with the addition of a fifth, viz., impairment of function.

Heat.—An inflamed part feels hot to the touch, and the temperature, if taken by a surface thermometer, will be definitely raised above that of the surrounding skin. The cause of this is the increased amount of blood flowing through it. Cohnheim has shown that nearly twice as much blood returns from an inflamed paw of a dog as from a healthy one; whilst others have demonstrated that the temperature of an inflamed area is never higher than that of the blood at the centre of the circulation, *i.e.*, in the heart. Necessarily where active chemical and pathological changes are occurring, as in an inflamed tissue, a certain amount of heat is produced; but it is relatively so infinitesimal in quantity that it may be neglected. The cause of the increased temperature of the blood is noted elsewhere (p. 18).

Pain.—This is due to the irritation of the peripheral nerve terminals, both by the increased arterial tension, and by the pressure of the exudation, so that it is much increased if, from the density of fascial or fibrous investments, swelling cannot readily occur, *e.g.*, in the palm of the hand, or in the eye or testicle. Possibly the exudation may have some direct irritating action on the nerve terminals.

The special feature of inflammatory pain is that it is always increased on pressure, whether intrinsic—*i.e.*, by increasing the blood-pressure—or extrinsic from external agencies. Thus, if an inflamed finger or hand is allowed to hang down, the pain is much increased, whereas elevation of the part causes speedy relief.

The pain of *suppuration* is throbbing in character; of an inflamed *mucous membrane*, scalding, burning, or gritty; of an inflamed *serous membrane*, stabbing; of inflamed *bone*, aching or boring, and often worse at night; of an inflamed *testicle*, sickening. When the organs of *special sense* are inflamed, there may be little real pain, but much exaggeration of the special sense, *e.g.*, flashes of light in retinitis and noises in the ears in otitis interna.

The pain is not always limited to the inflamed part, but is often experienced also in distant regions, either through a similarity of nerve-supply or from the fact that a sensory stimulus is always *referred* by a patient to the end of the affected nerve. For example, in *hip disease* the chief pain is often felt in the knee, because the two joints have a similar nervous supply. Thus the hip-joint is supplied by the great sciatic through the nerve to the quadratus femoris, by the anterior crural through the nerve to the pectineus, and by a twig of the obturator entering through the cotyloid notch. The knee is supplied by the great sciatic through the three articular branches of the popliteal, by the anterior crural through the nerves to the vasti, and by the deep branch of the obturator entering at the posterior ligament of Winslow. In *renal calculus* or colic, pain is referred along the course of the genito-crural nerve into the groin and front of the thigh, and is often accompanied in the male by retraction of the testicle on the side affected. In *spinal caries* pain is frequently referred to the terminal branches of the nerves issuing from the part affected, *e.g.*, the so-called 'belly-ache' of dorsi-lumbar disease.

Redness is due to the hyperæmic condition of the inflamed part; it is, of course, only present when tolerably superficial regions are involved, and its intensity varies with the stage of the inflammatory process. In the early active hyperæmia the colour is a bright rosy-red, fading rapidly on pressure, and returning equally quickly. In the stage of retardation the redness is more dusky, since the blood is longer in passing through the capillaries, and so becomes more deoxygenated; the colour does not disappear or reappear so rapidly, and a slight yellowish tinge often remains from extravasated hæmoglobin. When stasis is reached, and *a fortiori* when thrombosis, pressure will not remove the red colour, and, should such a state persist for long, definite and permanent pigmentation of the part may remain.

The redness is not always most marked at the focus of the disturbance, as the portion inflamed may be non-vascular, *e.g.*, the cornea or articular cartilage; in the former of these, the redness is most marked in the ciliary region as a zone of deep pink injection. The same absence of redness is observed in iritis, owing to the excess of pigment hiding the dilated vessels; but in both cornea and iris, the inflammation may in rare cases be so prolonged or acute as to cause these structures to become evidently vascular—in the one case from the formation of new vessels, and in the latter by the total removal and absorption of the pigment.

Swelling is the last of the Celsian signs of inflammation, and is due to the same two causes, viz., the hyperæmia of, and the exudation into, the part. Necessarily the amount of tumefaction depends upon the acuteness of the disturbance, and the distensibility of the tissue, and in measure it varies conversely with the amount of pain. In some cases where the inflamed area is covered by a thick and firm fascia, not only is the tensive pain very considerable, but swelling may occur away from the inflamed area, *e.g.*, over the back of the hand in palmar abscess. As a rule, where the inflammatory products escape into lax tissues the subjective phenomena are minimised. Similar illustrations of the occurrence of œdema at a distance are to be seen in inflammations of the sole of the foot, of the eyelids when the scalp is inflamed, and in cases of subcranial suppuration in which, if there is no external wound, an œdematous condition of scalp is seen, known as Pott's puffy tumour. Swelling due to inflammation, though diminishing *post mortem*, does not entirely disappear.

Impairment or Loss of Function is another important concomitant sign of inflammation, and is due not only to the paralyzing effect of the process upon the function of the part, but also in measure to the pain which is often elicited by attempting to use it. Thus an inflamed eye can see but little; a muscle, when inflamed, is naturally kept at rest; glandular organs, *e.g.*, the liver and kidneys, have their functions, if not lost, at least much diminished; and many similar illustrations might be added.

General or Constitutional Symptoms.

These may be of a serious character, if the organ affected is an important one, such as the kidneys or heart; but such conditions we cannot discuss here. Suffice it that the general symptoms of local inflammation of parts, not of vital importance, may be written in one word, viz., **Fever**, or pyrexia. The general characteristics of the febrile state may be briefly stated to be a greater or less elevation of temperature, accompanied with a corresponding acceleration in the rate of the heart-beat and of the respirations. If it continues for any time, the patient becomes thin, emaciated, and loses muscular power. The mouth is dry, and the tongue furred; and in the later stages, where a fatal issue is apprehended, the lips and teeth are usually covered with sordes (or accumulations consisting of inspissated mucus and food débris). The appetite is impaired, digestion is imperfect, and the bowels constipated; any motion passed is exceedingly offensive. The urine is scanty and high-coloured, and contains an excess of urea and urates, the products of excessive tissue change, as demonstrated clinically by adding an equal part of cold nitric acid in a test-tube to some urine, when crystals of nitrate of urea will form on the top of the fluid, giving rise to a mass somewhat resembling sugar-candy in appearance. The skin of a febrile patient is often dry, but by no means necessarily so.

In former days, when the practice of excessive bleeding was in vogue for all inflammations, the appearance of the *blood* was carefully noted, as it was supposed to throw some light upon the patient's condition. We now know that the blood when drawn from the body does not coagulate rapidly in many inflammatory affections, and hence the coloured corpuscles running into rouleaux or masses sink, leaving the upper part of the fluid almost colourless, and this on clotting will form a yellow or 'buffy coat' in contradistinction to the darker mass below. Inasmuch as there is relatively more fibrin in this upper stratum than in the lower, it will contract more readily, and thus become 'cupped' or concave on its upper surface. Such changes, however, occur in conditions other than inflammation, *e.g.*, after severe exercise, during and after pregnancy, etc., and so are of no clinical import. The red corpuscles are not much affected by simple inflammations; but in septic and infective cases they are broken up and the hæmoglobin is disseminated through the plasma (p. 91). From recent observations it appears that the white corpuscles are increased in number in all inflammatory affections which go on to suppuration, especially if the pus is pent up in a cavity.

The terms *crisis* and *lysis* are applied to the terminations of the febrile state, the former implying a rapid disappearance of the fever, accompanied usually by what is known as a 'critical evacuation,' either from the skin, bowels, or kidneys; the latter term indicates a gradual defervescence.

Causes of Fever.

The temperature of the body, it is well known, is controlled by a principal heat-governing centre in the medulla, assisted possibly by accessory centres in the cord, and is maintained by the establishment of equilibrium between the amount of heat lost from the skin, by the breath, and in other directions, and the amount of heat produced by the tissue metabolism occurring in the viscera generally, and especially in the voluntary muscles. Pyrexia is necessarily due to one of two conditions, viz., a decreased loss of heat, or an increased production. The former is a scarcely tenable proposition when we look at the patient's condition, and hence we are driven to conclude that fever is due to increased activity in the heat-forming tissues, especially the muscles, a fact which explains the rapid emaciation and loss of strength under such circumstances, and the existence of a large amount of extractives in the urine. In all probability this increased activity is due to the excitement of the heat-producing centre by some pyrogenous body developed by the local inflammatory process. Experiments have shown that the fibrin ferment, as well as many of the toxines produced by the action of micro-organisms, if injected into the circulation in a pure state, possess such a power, although it is quite an open question whether these bodies act through the nervous system, or directly on the tissues.

In regard to the symptoms of fever, it may be stated briefly that they are in large part due to the effect produced by the increased temperature upon the constituent cells of glandular and other organs; it is still uncertain whether such changes can be explained simply by the pyrexia, or whether they are not due to alterations in the composition of the blood. The phenomena in question are termed by different pathologists 'acute or cloudy swelling,' 'granular degeneration,' 'albuminous infiltration,' etc., and are characterized by the organs becoming soft, friable, and more or less swollen. The secreting cells of glands are increased in size, and the protoplasm becomes markedly granular, so that the nucleus can only be distinguished with difficulty. The granules are albuminous in character, clearing up completely on the addition of acetic acid. A similar change is also evident in the fibres of the cardiac muscle, which lose their striation and become granular, a condition which must considerably interfere with its contractility. The effect produced upon the glands of the digestive system explains many of the febrile manifestations, inasmuch as their function is largely impaired. The salivary and buccal glands are unable to excrete the normal amount of saliva, and hence the mouth becomes dry. Gastric digestion is interfered with in the same way. The bile is not efficiently produced, and hence its fat-emulsifying properties are diminished, as also the natural antiseptic and cathartic powers. Hence the patient cannot properly digest fats, and is constipated; his motions also become extremely offensive from the same cause.

Various terms have been applied to different *types of surgical fever*, *e.g.*, sthenic and asthenic, but it must be clearly remembered that these refer to clinical diversities of manifestation rather than to pathological distinctions of disease, and such sometimes depend as much upon the constitution of the patient as upon the nature or cause of the affection. By **Sthenic** inflammatory fever (Greek, *σθενος*, strength) is meant that condition in which pyrexia and all its accompanying symptoms are well marked. It occurs mainly in young healthy adults of sound constitution, as, for example, when a young man is suddenly attacked by acute pneumonia, or when an acute abscess is forming. **Asthenic** inflammatory fever (Greek, *ασθενος*, without strength) is characterized by the tendency to exhaustion and collapse associated therewith. It is met with in debilitated subjects and those exhausted by vicious habits, but may also occur at the close of a long period of pyrexia, *e.g.*, in the third week of typhoid fever (=the typhoid state). The absorption of products of putrefaction and the occurrence of acute infective blood-poisoning will also induce fever of this type in most cases. The temperature is not necessarily high, and, in fact, towards the end may become subnormal. The patient lies upon his back, more or less unconscious, in a state of muttering delirium; the hands are restless, constantly picking at the bed-clothes; the eyes may be open and with an unnatural lustre, or half closed, whilst the tongue becomes dry and brown from the mouth not being shut. Respiration is shallow and rapid, and the pulse quick and feeble. The excreta are often passed into the bed, and the skin is hot and dry at one moment, and then again covered with a clammy offensive perspiration. Should this state of things continue, death from coma or exhaustion is inevitable; on the other hand, a change for the better may be heralded in by a critical evacuation of the bowels, or a copious action of the skin. In some forms of asthenic fever nervous symptoms predominate, resulting in the production of a state which can scarcely be distinguished from delirium tremens.

The recognition of these different types of fever is most important, in that the constitutional or general treatment must be guided entirely by the symptoms manifested.

Causes of Inflammation.

Predisposing Causes.—The conditions which predispose to inflammation may be conveniently divided into the local and the constitutional.

The *local causes* include the following more important conditions:

1. Defective circulation, whether due to chronic anæmia, as in a limb with rigid calcareous arteries, or to passive congestion, as in a leg with varicose veins.

2. Loss or impairment of the nervous supply to a part, rendering it less resistant to external irritation either from loss of sensation, diminished trophic control of the nervous centres, or circulatory changes.

3. One attack of inflammation often leaves a part weaker and more liable to recurrence.

The *general or constitutional predisposing causes* are those which tend to depress the general vitality, *e.g.:*

1. Old age, where the body as a whole suffers in its nutrition.

2. Weak action of the heart, disturbing the vascular supply of the organs and members of the body.

3. An unhealthy condition of the blood, as from (*a*) the addition of some abnormal constituent, as in alcoholism, plethora, lead, mercury, or phosphorus poisoning, septic diseases, diabetes, etc.; (*b*) the insufficient elimination of excreta, as in Bright's disease or gout; (*c*) the absence of some normal constituents, as in albuminuria or anæmia.

4. The presence of some constitutional disease, dyscrasia or diathesis, as syphilis, tubercle, rheumatism, etc.

Exciting Causes.—The active agent in the production of any inflammation is the existence of some irritant which acts for a shorter or longer period upon the tissues. The different forms of irritants are infinite in number, but may be grouped under the following four headings:

1. Mechanical or traumatic causes, such as direct violence, friction, tension, pressure, etc.

2. Causes which act through changes of temperature, either heat or cold.

3. Electricity, either as applied by the surgeon in the form of the faradic or galvanic current, or through the agency of lightning, or the strong currents used for lighting purposes.

4. Toxic irritants, under which may be included:
   - (*a*) Chemical agents, such as strong acids or alkalies.
   - (*b*) Vegetable irritants, *e.g.*, croton-oil, oil of mustard, etc.
   - (*c*) Animal irritants, such as cantharides, and insect or reptile bites.
   - (*d*) The development of micro-organisms within or without the body.

Micro-organisms play such an important part in the development of disease that special attention must be given to this cause of inflammation. Four chief classes of micro-organisms exist, and a short notice of each is required.

I. The **Fungi** or **Ascomycetes** (Fig. 2, I.) are characterized by the growth of a mycelium or mass of interlacing fibres or threads, arising from which are the spore-bearing conidia, whence multiplication of the growth ensues. There is a great variety of fungi in Nature, but the more important pathological conditions due to their development in the body are as follows:

Thrush, due to the *Oidium albicans.*
Ringworm, due to one or more forms of *Tricophyton tonsurans.*
Favus, arising from the *Achorion Schönleinii.*
Pityriasis versicolor, due to the *Microsporon furfur.*

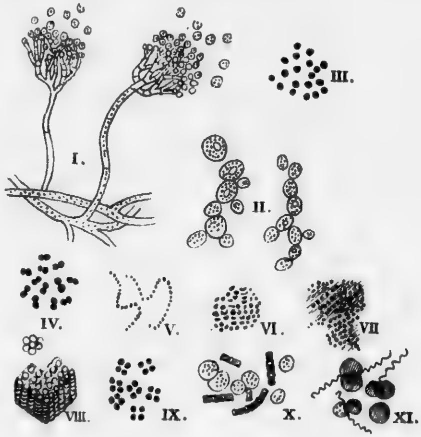

FIG. 2.—DIAGRAM OF VARIOUS FORMS OF MICRO-ORGANISMS (AFTER TILLMANNS.)

I., Mycelium and spore-bearing conidia of fungus (*Penicillium glaucum*); II., yeast organism, undergoing multiplication by gemmation; III., single or isolated cocci; IV., diplococci; V., streptococci or chain cocci; VI., staphylococci or cluster cocci; VII., zooglœa mass of organisms; VIII., sarcinæ; IX., cocci arranged in fours; X., bacilli; XI., spirilla, with blood corpuscles.

Kerato-mycosis, or parasitic ulcer of the cornea, is due to fungi of the aspergillus or mucor type (common moulds), which may also be found developing in the bronchi (pneumo-mycosis), or in the external auditory meatus (otomycosis).

Actinomycosis (p. 131) is dependent on the growth in the tissues of the ray fungus, or *Actinomyces.*

II. The **Yeasts** or **Blastomycetes** (Fig. 2, II.) develop by a process of gemmation or budding. They are responsible for many forms of fermentation, *e.g.*, the alcoholic or acetous, but play no recognised part in human pathology.

III. The **Protozoa** are a group which can be classed either as animal or vegetable, and consist in their earlier stages of masses of naked nucleated protoplasm, which may later on become covered with membranous envelopes, through openings in which pseudopodia are protruded. They constitute a large and varied class, the simplest form being the amœba; but their influence in pathology is as yet not fully worked out, and, indeed, we are only just commencing to realize that they play any part in it at all. It is supposed that the following varieties are of pathological importance:

Amœbæ are known to occur in certain forms of colitis, and also in some varieties of hepatic abscess.

Malaria is probably due to the development of a protozoon, the *Plasmodium malariæ*.

The *Psorospermiæ*, which occur not unfrequently in animals, are members of this group, and it is still a moot question whether the coccidia-like bodies found in Paget's disease of the nipple, and in some cases of carcinoma, are really living parasites, and if so, whether they have any causative effect on the origin of the disease (p. 155). Molluscum contagiosum is another condition which has been attributed to these organisms.

IV. The **Bacteria** or **Schizomycetes** form a very important and numerous class, and are in the present day looked upon as the essential cause of putrefaction, suppuration, and most of the inflammatory diseases. They are classified under the following different groups:

1. **Micrococci** or **Cocci** (Fig. 2, III.) are roundish or oval cells, multiplying rapidly by a process of fission (*i.e.*, division into equal parts). They may remain isolated, but as a rule are collected into certain definite formations, and in consequence are termed *staphylococci* or cluster cocci (Fig. 2, VI.) when they are grouped like a bunch of grapes, usually occurring thus in localized inflammations; *streptococci* or chain cocci (Fig. 2, V.) when they develop in chains, the characteristic of spreading inflammations; *diplococci* (Fig. 2, IV.) when they occur in pairs, *e.g.*, the gonococcus or pneumococcus met with in gonorrhœa and pneumonia respectively. When they are grouped into packets of four or eight individuals, they are usually termed *sarcinæ* (Fig. 2, VIII.). Occasionally any of the above may occur in masses or colonies, slimy or gelatinous in character, and known as a *zooglœa* (Fig. 2, VII.).

2. **Bacilli** or rod-shaped bacteria (Fig. 2, X.) are found in the form either of long or short filaments made up of an aggregation of individual rods united end to end; or they may become curved and so form spiral rods, which may break up into the so-called comma-shaped bacilli; or they may persist in the body of their host as isolated rods within the substance of the cells invaded. They multiply by fission, or by the formation of spores in their interior. These latter are much more resistant and less easily destroyed than the parent rods. The spore may develop in the centre of the bacillus, as in the *B. anthracis*, or at one end, as in the so-called drumstick-shaped *B. tetani* (Fig. 16) or *B. diphtheriæ*.

3. **Spirilla** (Fig. 2, XI.) form corkscrew-like threads, possessing active power of movement. They probably multiply by spore formation, and in human pathology only occur in a few conditions, such as remittent fever.

A few facts may be added here as to the life history and mode of activity of these vegetable organisms.

Habitat.—Bacteria are almost universal in their distribution. Earth, air, and water are full of them, and especially so in populous neighbourhoods. The greater the number of the inhabitants, the larger the number of organisms in the air. On the high Alps, and in isolated, especially mountainous, districts, there are comparatively few, whilst in the air of a crowded hospital ward swarms of them are present, and these often of a most dangerous type. The surface of our bodies and the intestinal canal, moreover, teem with them, although in a healthy individual the solid organs, the blood and lymph, are practically free. Any condition of general weakness will facilitate their entrance into the system, or perhaps one should say, will diminish the resistance of the body to their presence and activity, and hence lay the individual open to the occurrence of diverse infective diseases.

Mobility.—The cocci are as a group incapable of active locomotion, although they manifest, in common with all minute non-living particles, 'Brownian' movements. Most bacilli and spirilla have in addition the power of moving from place to place, accomplished by means of cilia, which develop either at one or both ends as single filaments or in bunches.

Multiplication.—The power possessed by bacteria of multiplying is enormous. Two methods have been mentioned above, viz., fission, and the formation of endospores. In some varieties another plan is present, viz., one cell of a chain or mass becomes enlarged and endowed with new vitality, and from this arthrospore fresh generations are produced. Probably some hitherto unnoticed and undescribed sexual process is present in such conditions.

Results of Growth.—The activity and development of bacteria are physiological phenomena, carried out in accordance with the general laws governing animal and vegetable life, and requiring certain definite conditions to be present. The pabulum or food-stuff differs with the particular species, and the results of their growth vary in like manner. As to their environment in pathological conditions, one divides them into two great classes, according to whether or not they can develop in the living tissues. The *pathogenic* or parasitic bacteria can do so, producing what are known as 'infective' diseases; but when an organism can only develop in dead tissues, such as masses of slough, or in exudations of blood, serum, or pus, or in some non-living nutrient material, it is called a *non-pathogenic*, saprophytic, or carrion microbe, and the process set up is termed 'septic.' Occasionally, however, some of the pathogenic organisms are capable of continuing their development in dead tissues as 'facultative saprophytes,' and this property is one of great danger, in that it permits of extensive diffusion of the virus; the tetanus, anthrax, and malignant œdema bacilli are specially characterized by this property. The necessity for atmospheric air in their development constitutes the basis of the division of microbes into aerobic and non-aerobic. When they can grow in, and, indeed, require for their development, the actual presence of free air, they are termed *obligate aerobes*. If, however, they have the power of acquiring the oxygen they need from the nutrient tissues surrounding them, they are then known as *facultative aerobes*. *Anaerobic* organisms are those which require an atmosphere around them, from which oxygen is rigidly excluded, and such usually flourish best in nitrogen or hydrogen, *e.g.*, the bacillus of tetanus. All bacteria consume oxygen, and give off a larger or smaller amount of carbonic acid; but in addition certain special compounds are produced as the result of their growth, and at the expense of the surrounding pabulum. Various acid and alkaline bodies are formed, and some organisms or their products are capable of peptonizing albumin or of liquefying gelatine, a characteristic feature in the action of the *pyogenic* (pus-producing) bacteria, as otherwise the liquefaction of the tissues which occurs in suppuration could not obtain.

The most important products, however, of bacterial activity are the so-called **Toxines** or poisonous bodies, the presence and action of which determine the special features of most of the infective diseases. Two great classes of toxines exist, viz. (1) the *ptomaines* or cadaveric alkaloids, organic bases built up on the likeness of ammonium hydrate (NH_4HO); they unite freely with acids, and can be crystallized. Cadaverin, putrescin, and sepsin are illustrations of these products. Injected into animals, they produce definite toxic symptoms, and locally may lead to the formation of an abscess. (2) The *tox-albumins* are bodies which have only been recognised more recently, and are supposed to be of the nature of albumoses; probably most of the infective processes result in the production of these substances.

Colouring agents, by which they can be recognised, are also developed by some varieties, whilst others produce fluorescence of the nutrient media.

Methods of Examination.—These are in the main threefold:

1. *Microscopic Examination.*—High powers of the microscope are needed for this work, and even with them it is often difficult to determine the characters of any particular form of microbe under examination. Minute differences in the size and shape may assist, and the relative arrangement in chains, clusters, etc.; but the reaction to different staining reagents is in this direction, perhaps,

the most important fact to ascertain. Into the various methods of demonstrating and staining bacteria it is impossible to enter here.

2. *Cultivation* on various nutrient media is of the greatest assistance in determining the exact nature of any special organism under examination. For this purpose the cut surface of a raw potato after sterilization of the exterior suits excellently in many cases. Fluids, such as meat infusion, milk or blood serum, are not very satisfactory; but similar materials, solidified by the addition of gelatine or agar-agar, and either placed in test-tubes or on plates, are the most suitable nutrient bases. In testing the life-history of any microbe, it is important to note whether or not it will develop in contact with the air. This may be accomplished by the use of nutrient gelatine poured into test-tubes, some of which are allowed to cool in the vertical position, and others on the slant. The former are inoculated by puncturing the horizontal surface with an infected platinum wire (stab culture), the latter by streaking it along the oblique surface (streak culture), (Fig. 3).

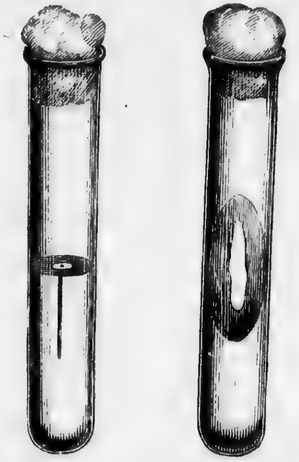

FIG. 3.—STAB AND STREAK CULTURES FOR BACTERIA. (AFTER TILLMANNS.)

3. *Inoculation* experiments are really the most reliable means of examining into the relations of micro-organisms to any particular disease; but it must be always fully recognised that animals are not necessarily affected in the same way as man, and therefore a bacteriologist must also be somewhat of a comparative pathologist. The importance of this means of investigation has been emphasized by Koch, who has insisted on the following four essentials in order to prove the infective character of any particular disease:

(i.) The organism must be present in every case of the disease, either in the tissues or in the blood.
(ii.) It must be possible to cultivate it for many generations apart from the body.
(iii.) Its inoculation into a suitable animal must be followed by the appearance of the specific disease; and
(iv.) The organism must be found in the tissues or blood of the animal infected in this manner.

The question of **Immunity** from infective diseases has been, and still is, receiving the greatest attention from bacteriologists. Three different kinds of immunity exist, viz.:

(*a*) *Natural immunity*, by which is meant that certain individuals or animals are capable of resisting the action of microbes, which can develop in others; thus, rats are unharmed by anthrax bacilli, and goats by those of tubercle. This condition also obtains in the human subject where certain individuals seem to be immune against particular diseases.

(*b*) *Acquired immunity* is that condition in which an individual is free from the danger of contracting a specific disease owing to his having already acquired it. Thus, one attack of any of the ordinary exanthemata or of syphilis, as a rule, protects him from further danger from that special affection. Occasionally, however, this immunity seems to wear itself out, and second attacks may then occur.

(c) *Artificial immunity* is the protection against infection which is obtained by artificial means devised and designed by science. Various plans have been introduced to effect this object, of which the following are the most important: (i.) Inoculation with the specific disease in such a way and at such a time that the patient can readily throw it off. This was formerly employed as a preventive against small-pox, but not with particularly great success. (ii.) Inoculation with an attenuated or modified virus, which, whilst not giving the patient the original disease, has yet such an effect on his constitution as to protect him from it. This has been used with good results in the prevention of anthrax in animals. (iii.) It is probable that most organisms have the power of developing materials of the antitoxin type, which are capable of inhibiting their own development, and it is the great aim of bacteriologists to isolate such substances, so as to place them at the disposal of the practitioner. The serum of immunized animals contains this substance, and has been employed as a curative agent in several diseases, as well as for protective purposes. (iv.) Inoculation with the virus of some other disease is possibly a means of prevention or cure, as in the case of vaccination to prevent small-pox, although there is a certain amount of doubt as to whether or not the two conditions are identical.

Resisting or Antiseptic Power of the Tissues.—If we are surrounded with, and if our bodies even are invaded by, so great a swarm of enemies, many of which could under suitable circumstances produce grave diseases, there must be present within us some potent natural means of resisting their activity, and such is termed the antiseptic or germicidal power of the tissues. There can be no manner of doubt that bacteria are destroyed in the body; some are possibly excreted by the kidneys, but of this we know but little. There are two main theories as to Nature's means of destroying or preventing the action of bacteria in the body, viz.: (1) Metchnikoff's theory of **Phagocytosis**, which maintains that the leucocytes, and also the larger round cells derived from the connective-tissue corpuscles, described elsewhere as fibroblasts, have the power of taking into their substance the microbes, and of there destroying them by a process of digestion. This idea is based on the results of microscopic examination, it being tolerably easy to demonstrate the presence of bacteria within the living leucocyte (Fig. 4), although opponents to this theory suggest that it is only the dead organisms which are swallowed and dealt with in this way. As an important outcome

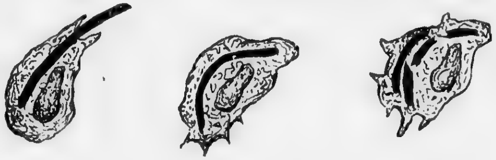

FIG. 4.—PHAGOCYTOSIS. (TILLMANNS.)

In the first figure the rod-shaped organism is being absorbed or swallowed by the phagocyte; in the second it is incorporated in its body, and in the third it is being disintegrated.

of this doctrine has arisen the idea of **Chemiotaxis**, a term introduced to indicate the attractive or repulsive power exercised by the bacteria upon the leucocytes. By *positive* chemiotaxis is meant the attraction whereby leucocytes are gathered towards any tissues in which bacteria have commenced to develop; the organisms or their products seem to have a power of causing active diapedesis and exudation of plasma, as a result of which the spread of the microbic invasion is limited, and the inflammation thus caused is protective rather than destructive. Positive chemiotaxis is to be looked on, then, as Nature's defence against an active and vigorous microbic attack. *Negative* chemiotaxis, on the other hand, is the term applied to a condition in which the leucocytes are apparently repelled by the organisms, on account probably of their virulent nature. Both phenomena can be seen very well by inoculating the cornea of an animal with the *Aspergillus niger*, as was done by Leber; the spot of inoculation looks opaque and dull, owing to the development therein of the mycelium of the fungus, and the necrosis caused thereby; around this is an area of clear corneal tissue which is necrotic, but free from leucocytes owing to negative chemiotaxis. Outside this, again, is a circle of infiltrated tissue, at first of a whitish-yellow colour, and finally breaking down into pus, the result of positive chemiotaxis. (2) More recently the theory of phagocytosis has been very vigorously attacked, and it has been maintained that the chief germicidal powers of the body reside in the blood serum and its constituents. Certain special albuminous substances have been isolated, and to these the name of **Protective Albumins** or **Alexines** has been given. Probably there is truth in both these theories, the two different powers being called into play under varying circumstances.

Varieties of Inflammation.

Many terms are used clinically to indicate the different manifestations of the inflammatory process in the body, and to these we must now direct attention.

A **Catarrhal** inflammation is one affecting mucous membranes, evidenced clinically by the occurrence of redness, and a burning or scalding pain, which is most marked in the early or dry stage, when there is but little discharge, and is much diminished in the later stages, when there is free secretion of mucus, muco-pus, or pus. Pathologically, this process is accompanied, as are all active inflammatory changes, by hyperæmia and exudation. In the early stage the mucigenous function of the membrane is abrogated, and any extravascular exudation passes into its substance, causing it to become swollen. Proliferation of the epithelium soon follows, resulting in the increased formation of mucus; and as the membrane becomes more and more infiltrated with leucocytes, these are added to the discharge, and it is transformed into muco-pus, or even finally pus. Small ulcers may form from the loss of the superficial epithelium, but this is an exception rather than the rule. Microscopic examination of the discharge reveals pus cells, leucocytes, and epithelial cells in various conditions, some containing globules of mucin, and some of the normal type. This form of inflammation may be caused by bacteria, but is often due to the action of local irritants, or to what is known as 'taking cold.'

A **Croupous** (or plastic) inflammation is one characterized by the formation of a firm fibrinous false membrane. It may occur on a serous surface, as the pleura, peritoneum, or synovial membrane of a joint, in the form of plastic lymph, which may organize into adhesions; it is also seen in open wounds allowed to granulate, and it occurs in the alveoli of the lungs in lobar pneumonia. On mucous membranes, such as the conjunctiva or that of the pharynx, it occasionally forms white flaky masses, which can readily be detached, leaving an injected surface below, with merely a point or two of hæmorrhage, and no loss of substance.

A **Diphtheritic** inflammation is one due to a special organism—the *Bacillus diphtheriæ*—and is evidenced by the formation of a membranous exudation with which are incorporated the superficial layers of the epithelium, so that it cannot be removed without leaving a raw surface. The bacilli develop in this false membrane and produce toxines, which by their absorption give rise to the constitutional symptoms of the disease.

The term **Phlegmonous** is now but rarely employed. It was formerly used to indicate an inflammatory condition when all the local phenomena were well marked.

Parenchymatous and **Interstitial** are terms which indicate that in an inflamed organ or gland the process is respectively limited, either to the actual and active substance of the organ, or to the supporting fibrous tissue.

A **Metastatic** inflammation is one which completely leaves its original focus, and without apparent reason attacks some other part; thus, after mumps the testicle or ovary may become inflamed, whilst after laparotomies, especially those affecting pelvic organs, parotitis is occasionally seen, quite independently of pyæmia. Abscesses forming in the course of pyæmia are not of this nature, although they are even now frequently so called; they are really embolic in origin.

Treatment of Acute Inflammation.

It is only possible here to deal with the general principles which guide us in the treatment of inflammatory affections. The method of application of these to different parts of the body will be described hereafter.

The **Local Treatment** may be indicated under four headings:

1. *Remove the exciting cause*, if evident, and any contributory

causes where possible. This is not a difficult matter where the lesion is a gross one, and the exciting cause tangible—*e.g.*, a foreign body imbedded in the conjunctiva or cornea, or a piece of dead bone lying at the bottom of a sinus. Inflammatory tension from pent-up effusion is readily relieved by an incision or an abscess opened. But when dealing with inflammation the result of bacterial activity, it is often difficult either to localize the cause or to eliminate it. In certain cases it may be practicable to totally excise a local focus—*e.g.*, a malignant pustule—but unless undertaken at an early stage, the surrounding parts quickly become infiltrated, though this may not be evident to the naked eye. We have then to trust to the germicidal action of the tissues, supplemented in a few cases by the use of some special antitoxic serum, and also by such general measures as improving the health by good diet and suitable drugs.

2. *Keep the inflamed part at rest.* Wherever inflammation exists, steps must be taken to ensure both physical and physiological rest as far as is possible. Thus, an inflamed joint is immobilized by a splint; an inflamed mamma needs both support and the fixation of the arm, whilst if in a condition of physiological activity this must be checked by suitable treatment; an inflamed cornea requires the application of a pad and bandage to prevent the friction of the eyelid, whilst an inflamed retina must be put to physiological rest by exclusion of the light.

3. *Reduce the local blood-pressure* and hyperæmia, and thus diminish both the exudation and pain. Elevation of an inflamed limb may secure this end, and is a most essential element of the treatment of all inflammatory conditions of the leg, for it is a well-known fact that the emptying of the veins by gravity in an elevated limb leads to a reflex contraction of the arteries. The main artery of a limb has also been tied as a means of reducing the local blood-supply, but such a severe measure can be but rarely called for. Local blood-letting by leeches, punctures, scarification, and wet or dry cupping, may be recommended in suitable cases, and may give immense relief. It is unnecessary to mention here more than the fact that a leech can withdraw about 2 to 4 drachms of blood, and that it should not be applied over a large subcutaneous vein, or to parts, like the scrotum or eyelids, where there is much subcutaneous tissue of a loose texture, in which extravasation readily occurs. The bleeding from a leech-bite will usually cease spontaneously, or at most after the application of slight pressure.

Cold wisely utilized may be of the greatest service in combating inflammation by causing contraction of the arterioles, and so reducing the hyperæmia. It should only be used *in the early stages*, and never when suppuration is threatening, as, although it may cause local depletion of the bloodvessels, it at the same time depresses the vitality of the part, and so may do more harm than good. Again, it should be used with the greatest care in old people, from fear of causing sloughing of the skin. There are various methods of applying it, as by means of an ice-bag; or by irrigation from a vessel suspended over the part containing iced water or lotion, from which strips of lint descend to envelop the inflamed area; or a piece of lint wrung out of evaporating lotion may be placed directly on the part, and constantly renewed; or, better still, the iced water may be run through a coil of leaden pipes (known as Leiter's tubes), fitted carefully over the inflamed region. Under any circumstances the cold must be continuous, and not intermittent, as otherwise the alternating periods of anæmia and hyperæmia will have a baneful rather than a beneficial influence.

Heat, especially when combined with moisture, is very largely used in treating inflammatory affections, and acts in a diametrically opposite way to cold by relaxing the vessels and tissues, thus reducing the tension and pain, assisting exudation and migration, and diminishing the tendency to stasis; it also favours the activity and vitality of the part by increasing the vascular supply and facilitating lymphatic absorption. When suppuration is threatening, the application of warmth and moisture hastens the process. For subcutaneous lesions, hot fomentations, medicated or not with opium or belladonna, or spongiopiline wrung out of hot water, or simply dry heated cotton-wool, may be employed. When an abscess is forming, nothing can be more soothing and satisfactory than a linseed-meal poultice, provided that the abscess is not allowed to burst into it. They should never be applied to open wounds or abscesses unless the latter are in a very unhealthy state from diffuse cellulitis, and then the poultice should be rendered more or less aseptic by making it with hot carbolic lotion (1 in 30). The boracic poultice or fomentation is most useful in many superficial inflammatory affections due to sepsis, dirt, and want of attention. It consists in the application to the part of a portion of boracic lint wrung out of a hot boric acid solution (1 in 20), and covered with oiled silk or guttapercha tissue.

4. *Prevent the access of fresh sources of irritation or infection*, such as those due to putrefactive changes in an open discharging wound. Some of the methods and agents for maintaining asepsis are described in Chapter VII. under the subject of the treatment of wounds, and do not need to be discussed here.

The **General Treatment** of inflammation varies considerably with the condition of the patient, and as to whether he is strong and healthy, or weakly. Those who are depressed in health, or who may be expected readily to become so from the continuance of the febrile state, will need to be carefully supported by a tonic plan of treatment, whilst at the same time attention must be directed to the elimination of toxic bodies by suitable purgatives, diaphoretics, and diuretics. Quinine may be given with great benefit, as also diffusible stimulants, such as ether or carbonate of ammonia, whilst the recovery of patients lying in a typhoid state of exhaustion will absolutely depend on the administration of nourishing fluids, combined with stimulants and bark at short intervals. In the sthenic type of inflammatory fever, 'antiphlogistic' means may be freely employed so as to reduce the general blood-pressure, and remove irritating matters from the system. In the majority of cases a smart purge, followed by low diet and abstinence from alcohol for a few days, will be all that is necessary; but in other instances where the blood-tension is high, as indicated by a large and full pulse, and the local signs (pain, etc.) are well marked, it may be also necessary to administer such drugs as antimony, aconite, full doses of acetate of ammonia, colchicum or ipecacuanha, to reduce the general blood-pressure, as also to obtain diaphoretic action. In a few cases—*e.g.*, acute meningitis—venesection may be needed, but this is an agent little employed in the present day. In some forms of inflammation, due to the specific diatheses, suitable drugs must be employed to combat such tendencies—*e.g.*, salicylate of soda or salicin in acute rheumatism.

Chronic Inflammation.

The phenomena of chronic inflammation are much the same in essence as those of the acute process, but the manifestations are somewhat different. Hyperæmia and exudation occur, but the tissue reaction is much more prominent. The main differences in the two processes are as follows:

1. The hyperæmia is less in amount, but longer in duration, owing to the fact that the causative irritant is similarly less intense in action, although spread over a longer interval. The local manifestation will therefore be less obvious; there is not so much pain, which is mainly of an aching character, and less heat, whilst the redness is more dusky, and the tissues tend to become pigmented. Considerable loss of tone in the vessels, especially the veins, results from the prolonged distension, and thus there is much greater difficulty in restoring them to a normal state.

2. The corpuscles do not tend to adhere together or run into rouleaux to the same extent as in acute inflammation, and migration, though it exists, is on a limited scale. The exudation is much more fluid in character, containing comparatively little albumin or fibrin; in fact, in some chronic inflammations of serous membranes the cavities are distended with fluid of a much lower specific gravity than that of blood serum.

3. The greatest difference in the acute and chronic processes lies in the reaction of the tissues, which in the former are in a much more depressed or passive condition than in the latter. They become infiltrated with round cells, derived more from the connective-tissue elements than from the leucocytes, and hence

organization is much more marked here than in the acute form. Tissue destruction, then, is a much less prominent feature of the early stage of chronic inflammations, although as a secondary change, especially in tubercular and syphilitic diseases, it is often seen.

The **Causes** are similar in character to those producing the acute mischief, but slighter and more prolonged in their action, and thus tend to produce tissue proliferation rather than tissue destruction. The most striking point in the ætiology is the large part played by diathetic conditions or constitutional predispositions. Most of the manifestations met with in surgical practice are due to syphilis, tubercle, gout or rheumatism, and one should never treat such a case without carefully inquiring as to the possible existence of some such taint.

The **Results** of chronic inflammation vary considerably according to the part of the body affected, and also with the predisposing diathetic state, and we can at this place only epitomize a few chief points worthy of being noticed by the student.

In **Simple** chronic inflammations the part becomes infiltrated and enlarged, mainly from proliferation of the connective tissues. Thus, a bone is thickened and condensed in chronic osteitis, whilst in chronic periostitis a new subperiosteal deposit of bone may occur. Glands become larger and indurated, mainly by hyperplasia of the connective tissue, whilst if the skin is involved it may either become increased and thickened in bulk, as in chronic hypertrophic eczema, or it may entirely lose its characteristic structure, and be converted into granulation or fibro-cicatricial tissue, with or without an intervening ulcerative stage. True suppuration occurs but rarely, although certain specific organisms of a low virulence may occasionally lead to its development.

In chronic **Tubercular** inflammation the tissue of the part is replaced by pulpy œdematous granulation tissue, scattered through which here and there are definite tubercles, which may run together and lead to the formation of caseating foci; these in turn may either result in suppuration or ulceration, or may undergo calcification, and their extension be limited by a sclerosing process around them. A diffuse overgrowth forms the earliest stage, and this is often followed by destruction of the involved tissues, and possibly disorganization of the parts with or without suppuration.

In chronic **Syphilitic** inflammation (tertiary) the most marked feature is an invasion of any of the connective tissues by a fibro-cellular exudation and hyperplasia, which may be diffuse or localized; if the former, general sclerosis of the part results, *e.g.*, in the stony-hard tertiary testicle; in the latter, a gumma is developed, which usually undergoes central degeneration and bursts, giving exit to a gummy fluid, and leaving a leathery-looking slough behind.

In all these varieties of chronic inflammation a marked proliferation is always found in the tunica intima of the arteries of the inflamed area, the result of an associated *chronic endarteritis*.

Constitutional symptoms are but little evident, beyond those dependent on the diathetic condition to which the local phenomena are due, or to septic changes developed secondarily.

The **Treatment** of chronic inflammation is usually much more prolonged and difficult than that of acute cases, because of the constitutional dyscrasia which exists so frequently behind it.

1. The *cause must be removed* whenever possible. Dead or diseased bone must be taken away by operation, if feasible, and tubercular material must be got rid of by the knife or sharp spoon, whilst it is often desirable to supplement this by the subsequent application of pure carbolic acid. A chronic abscess is liable to increase the action of the original irritant through the tension engendered by its presence, and hence it should be dealt with as early as possible under the strictest antiseptic precautions.

2. *Keep the part at rest.* This is just as much an essential as in the treatment of acute inflammation. Joints must be immobilized; the spine must have the weight taken from it by suitable appliances, or, better still, by maintaining the recumbent position; secretory glands must not be actively exercised, and sense organs must be protected from irritation.

3. *Counter-irritation* is one of the most useful forms of treatment for chronic inflammatory conditions. It is applied in many different ways, according to the character of the disease and the part involved. Thus, friction with the naked hand, or with stimulating embrocations, produces a hyperæmic condition of the skin, and promotes local activity in the superficial parts which may react beneficially on deeper structures. Scott's dressing may be similarly employed; it consists in wrapping up the part (*e.g.*, a joint) in strips of lint covered with ung. hydrarg. co. (containing over 10 per cent. of camphor), and then encircling it firmly with soap plaster, spread preferably on chamois leather. Iodine paint is another useful application, whilst blisters are most valuable in suitable cases. The moxa, a wound produced by burning a spirituous solution of saltpetre on the skin; the issue, the maintenance of a raw surface, however produced, by the constant presence of some irritant, such as the insertion of a bead, or the use of savin ointment as a dressing; and the seton, a double thread knotted at each end, passed for some distance under the skin, and drawn from end to end daily—all these are but little used now, although they might be occasionally employed with advantage. The actual cautery is the most severe form of counter-irritant, and is especially useful in some varieties of chronic inflammation of bones and joints. Various theories have been suggested to explain the method of action of counter-irritants, but there is still a good deal of doubt on the subject.

4. *Pressure* is a most important element in the treatment of

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chronic inflammatory disorders, and probably acts by artificially bracing up the vessels of the part which have become relaxed and atonic from the prolonged distension to which they have been subjected. It may also act by inducing the absorption of the inflammatory exudation. Firm bandaging, and especially the use of an elastic support in suitable cases, is the most satisfactory method of application.

General or constitutional treatment must be also adopted to meet the specific diatheses which are so commonly associated with chronic inflammation, *e.g.*, mercury or iodide of potash in syphilis.

CHAPTER II.

SUPPURATION AND ABSCESS.

WHEN the inflammatory process results from the action of certain micro-organisms, known as pyogenic, liquefaction of the inflamed tissue and of the exudation follows, the liquefied material being known as *pus*, and the process which leads to its formation as *suppuration*. Any localized collection of pus is known as an *abscess*, and of such two great varieties are described—the acute and the chronic.

Acute Abscess.

Ætiology.—A large amount of experimental work has been undertaken to ascertain the relations of bacteria to acute suppuration, and from the mass of evidence—mainly concordant, but occasionally conflicting — the following conclusions may be drawn:

(*a*) That *bacteria are present in all acute abscesses*, either in the pus, or in the abscess wall, or in both. Ogston of Aberdeen was the first to proclaim this fact, and it is now generally accepted. The failure to discover organisms in a few cases is quite possibly due to imperfect observations, or to the fact that they have died out owing to their low virulence and the activity of the surrounding tissues. The liver is one of the commonest sites to find sterile pus; possibly the bile may play some part in its occurrence.

(*b*) That such *bacteria can reach the inflamed area either from without the body or from within.* The former method is the more common, and is illustrated by the observations of Garré and Bockhardt, who rubbed cultures of *Staphylococcus pyogenes aureus* into the skin of their arms, and produced acute suppuration commencing in superficial pustules, and finishing as boils or carbuncles. The suppuration occurring in wounds is most commonly due to infection from without, but there can be no doubt that *auto-infection* occurs, by means of which an abscess can be produced by infection from within the body. This can only happen when the vitality of the patient is considerably depressed, and some local condition exists favourable to bacterial development. Thus, given a blood-clot or inflammatory serous exudation in an unhealthy depressed individual, whose germicidal power is low, suppuration is likely to ensue from auto-infection, the organisms being previously present in the blood; *e.g.*, the suppuration which occasionally follows a simple fracture or hæmatoma. An abscess thus produced may be termed an *idiopathic infective abscess.* Occasionally the microbes may be carried either *en masse* (*zooglœa* condition), or in the substance of a small portion of blood-clot, as an embolus, from one part of the body where an infected wound or injury exists to some other part, thus originating an *embolic infective abscess.* Pyæmic abscesses are of this type, and similar results may occur after gonorrhœa, and after typhoid and other fevers.

(*c*) That *ordinary irritating chemical products or sterilized foreign bodies* (*e.g.*, silver-wire or glass splinters) *do not produce suppuration,* except in the rarest of cases, by auto-infection. Thus, a ragged splinter of glass, an inch and a quarter long, and an inch and a half wide, the result of the bursting of a soda-water bottle, was cut out of the neck of a hotel porter ten months after it had entered; it had caused no suppuration. Experiments, moreover, have been made with sterilized croton-oil and other irritants, in which the substance securely sealed up in a thin glass capsule was implanted amongst the spinal muscles of an animal, and after a delay to allow the thorough healing of the wound was set free by a blow. No suppuration ensued, although a certain amount of putty-like fibrinous material was found at the site of operation; but the tissue-liquefying properties of bacterial ferments being absent, no true pus was found. On the other hand, injections of the ptomaines produced by bacteria (*e.g.*, cadaverin, putrescin, etc.) have resulted in suppuration, the tissues being liquefied into true pus by their activity.

In conclusion, therefore, although suppuration may be experimentally induced in animals under special circumstances, apart from micro-organisms, *in man for all ordinary conditions suppuration does not occur apart from the presence and vital activity of specific bacteria.* The causes, then, of an acute abscess may for practical purposes be grouped under the three following headings: (1) The individual affected is very possibly in a depressed and unhealthy state, and the germicidal properties of his tissues are defective. (2) A local nidus must exist, which is in a condition of depressed vitality, from injury, cold or otherwise; and (3) this spot must become infected with pyogenic organisms brought to it either from within or without the body.

Bacteriology.—As already stated, the pus of all acute abscesses contains living organisms, the nature of which, however, varies with circumstances. When suppuration occurs in wounds in which there is but little putrescible material, or arises idiopathically, it almost always results from a direct infection with one or more of the pus-producing pathogenic bacteria. In many so-called septic wounds, however, non-pathogenic bacteria are also present, leading to putrefaction of the discharge. The most important **Pyogenic Organisms** are as follows:

1. *Staphylococcus pyogenes aureus* is that most commonly found in all foci of localized suppuration. It can be readily cultivated on nutrient gelatine, agar-agar, or blood serum. On plate cultures it forms in two days golden-yellow colonies, as also in tube preparations. It is very resistant to chemical and thermal reagents, requiring several minutes' boiling to ensure its destruction. It produces no gas and no stinking odour in its growth, and is capable both of peptonizing albumin and of liquefying gelatine. It is a facultative aerobe (p. 23).
2. *Staphylococcus pyogenes albus.*
3. *Staphylococcus pyogenes citreus.*

These two forms are mainly distinguished from the former by the colour of the colonies formed in their growth; all their other properties are the same except that perhaps the *citreus* is a little slower in rendering gelatine fluid, whilst the *albus* is apparently not so virulent. The latter organism is very similar to, if not identical with, the *Staph. epidermidis albus*, which is widely scattered over the skin, and is usually found in the small abscesses developing in connection with tense stitches.

The staphylococci are mainly associated with the formation of localized abscesses. Thus, if a culture is rubbed into the skin of the forearm, a plentiful crop of boils, or perhaps a carbuncle, will result; if injected beneath the skin, a subcutaneous abscess may be formed, or even a typical carbuncle, if a sufficient number has been introduced, and if they are unfiltered so as to retain their toxines; if the peritoneal cavity is infected, suppurative peritonitis follows, provided that a sufficient quantity of the organisms is present; if a joint, suppurative arthritis. When injected into the blood-stream, there is but little effect if only a few are introduced; but when many, multiple abscesses in any and every part of the body may occur, as in pyæmia, or more frequently true septicæmia; if, soon after the injection of an amount not large enough to produce general infection, a bone or joint is injured, acute infective osteomyelitis or arthritis will follow; whilst if the cardiac valves are artificially damaged, a typical ulcerative endocarditis ensues. All these conditions may be produced artificially in animals, and, from the similarity of the symptoms and the microscopical appearance of the parts, we conclude that similar conditions in man are due to exactly the same causes, except that the infection is not artificial, but comes either from without as a result of local injury, or from the blood-stream.

4. *Streptococcus pyogenes* is an organism of great importance in pathology, as it is the main exciting cause of many inflammatory conditions. It is probable that there are several distinct species included under this title—indeed, it is claimed that six different forms have been isolated; further researches are, however, needed to make certain of this fact. It can be readily cultivated on most nutrient media, but grows slowly at the ordinary temperature of the air, and not very rapidly even at blood heat. It does not liquefy gelatine nor produce any colouring reagent, but has an energetic peptonizing power in the absence of oxygen. It occurs in chains of varying length, which may occasionally bifurcate.

The *Streptococcus pyogenes* is mainly associated with spreading inflammations of the cellulitic type, whilst it is a common cause of pyæmia, and even of acute septicæmia. It has also been found in many acute localized abscesses, in empyema, and in some forms of suppurative arthritis. It is probable that the streptococcus of erysipelas should be included in this group.

5. The *Bacillus coli communis* is an organism to which much attention has been directed of recent years. It is identical with the microbes formerly known as the *Bac. pyog. fœtidus* and the *Bac. lactis aerogenes.* It exists normally in the intestinal canal, extending from mouth to anus, but more frequently in the duodenum and colon, and probably plays a considerable part in the normal process of disintegration of food-stuffs. So long as it remains

within the bowel, it is perfectly innocent; but as soon as it is able to pass into or through the intestinal wall, as a result of any loss or diminution in its vitality or abrasion of its surface, it is liable to become intensely virulent, producing suppurative inflammation of the most acute type, or even necrosis. Hence it is the most common cause of acute suppurative peritonitis in all cases where the infection arises from the bowel, whilst it is also mainly responsible for the formation of abscesses in the neighbourhood of the tube, as in appendicitis, acute ischio-rectal suppuration, etc. One of its most characteristic features is that—even when cultivated in a test-tube—it produces a most offensive and penetrating odour, somewhat similar to that of decomposing fæces; such is also noticed in the pus produced by the organism.

6. The *Bacillus pyocyaneus* is occasionally met with in wounds, producing what is described as blue or green pus. It is of no clinical importance, except in a few cases where it has been known to give rise to general infection.

7. The *Pneumococcus* and *Bacillus typhosus* may also give rise to suppuration after pneumonia and typhoid fever respectively, but they are not specially virulent, and the abscesses are usually of a subacute type.

8. The *Gonococcus* must also be included in this category.

Pathological Anatomy of an Abscess.—The phenomena associated with the formation of an acute abscess are merely a further stage of those detailed previously as characteristic of inflammation. The vessels of the affected area become distended, and the various elements of the blood pass through the walls. As the organisms develop, the vascular phenomena of retardation and stasis followed by thrombosis occur successively, whilst the exudation of cells becomes so great that the original tissue of the part disappears, after passing through a stage of coagulation-necrosis (Fig. 5). This removal of the infiltrated tissues, though due in part to the defective blood-supply brought about by the pressure of the exudation and the vascular thrombosis, is mainly caused by their liquefaction owing to the peptonizing power of the bacteria present. The newly-formed tissue replacing them consists merely of a mass of round cells, the central portion of which

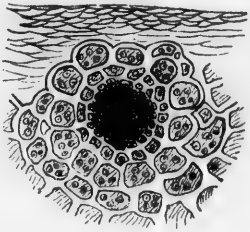

FIG. 5.—DIAGRAM OF AN ABSCESS IN PROCESS OF FORMATION.

In the periphery the vessels are seen dilated, but in the centre the structure of the part is indistinguishable, being replaced by a cellular infiltration undergoing necrotic changes, whilst the vessels are thrombosed.

is also liquefied and breaks down into pus. When once this has commenced to form, it depends entirely upon the character of the irritant, and the nature and behaviour of the surrounding tissues, as to what will subsequently supervene; but there is usually a tendency for it to increase steadily in amount. It may then find its way to the surface and point; it may burrow along fascial or muscular planes; or it may, somewhat less frequently, become circumscribed, and more or less chronic. As soon as the acute or extending process comes to an end, repair begins to manifest itself in the vascularization of the embryonic tissue, and its transformation into granulation tissue. Should the abscess point, the normal tissues in the line it travels along are in their turn transformed into embryonic tissue, which breaks down and liquefies as soon as it is formed, whilst granulations spring up from the floor and sides of the cavity, endeavouring, as it were, to obliterate the track the abscess has taken. Thus, a definite distinction must be drawn between the structure of its wall in the early and late stages, which, however, we often see coexisting in the same abscess. In the former or *early* stage of tissue destruction (Fig. 5), one meets with the following zones in passing from the centre to the periphery: (1) The central collection of pus; (2) a layer of breaking-down embryonic tissue; (3) embryonic tissue showing a trace of the original structure of the part in a state of coagulation-necrosis, and with the vessels thrombosed; (4) tissue of the part infiltrated with leucocytes, and with the blood-stream either stopped completely or retarded; (5) hyperæmic and slightly infiltrated tissue of the part, gradually shelving off into normal tissue. In the *later* stages (Fig. 6), where the inflammatory process is not spreading, the following zones may be described: (1) The central focus of pus;

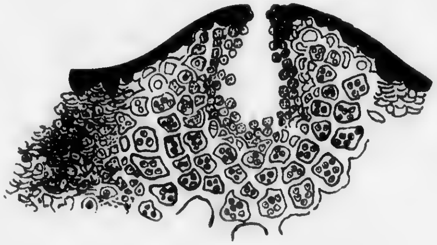

FIG. 6.—DIAGRAM OF THE LATER STAGE OF AN ABSCESS WHICH HAS JUST BURST.

The walls of the cavity are lined by granulation tissue, except at the extreme margin, whilst the parts around are hyperæmic and infiltrated.

(2) a layer of granulation tissue; (3) a layer of fibro-cicatricial tissue gradually merging into (4) the normal tissue somewhat infiltrated and hyperæmic.

The **Clinical Signs** and **Symptoms** of an acute abscess may be arranged under three headings:

1. The *local signs* consist of a localized patch of inflamed tissue, evidenced by heat, pain, redness and swelling, which latter is at first hard and brawny, but when pus forms the centre becomes soft, elastic, and fluctuating, whilst superficial œdema is more marked, and the pain more throbbing in character. Naturally, the amount of this pain depends entirely upon the density of the tissue affected, and the supply of sensory nerves to the part, suppuration beneath a dense resisting membrane, such as the palmar fascia, being always intensely painful. If left to itself, an abscess sooner or later points and bursts. As it increases in size, it exerts pressure in all directions, and naturally seeks to find an exit from its environment in the direction of least resistance, and so may either find its way to the surface, or may burrow along muscular and fascial planes, or into adjacent cavities. This is not merely a mechanical, but also a vital process, as already described. When the pus reaches the surface, it usually opens by a simple process of ulceration, although a large abscess may cause sloughing of the superficial covering by cutting off the supply of nutrient material from below.

2. *Pressure effects* are mainly due to the mechanical influence of the swelling upon surrounding structures. The most evident are those due to the irritation of nerves, as a result of which neuralgic pain may be present, or the patient may refer the pain to some distant unaffected region. In some cases, where bloodvessels are involved, the tissue around them disappears, and they are left in the abscess cavity as bands, surrounded by granulation tissue. Thrombosis and the subsequent obliteration of the vessel may result, or occasionally ulceration and hæmorrhage (ulcerative periarteritis). Tubes may be laid open by the pressure of an abscess, whilst joints may be invaded, leading to subsequent disorganization, and bones may become carious, or even necrosed. Such effects are more common in chronic than in acute abscesses.

3. The *general effects* of the formation of an acute abscess are simply those of increased fever, sometimes amounting to a rigor. A *rigor* consists of a definite series of phenomena, the result of some stimulating influence reaching the thermogenic centres of the medulla, determining a sudden increase of activity. It is very similar in nature to an attack of ague, being ushered in by a feeling of intense cold and discomfort; the features are pinched, and the teeth chatter. The skin, however, feels pungently hot, and the temperature of the body rapidly rises. The sensation of cold is partly due to the contact of air at a maintained normal temperature with the dry, hot, unperspiring skin, and also possibly to the

condition of superficial anæmia which is present. After this stage has lasted a variable period, the patient gradually begins to feel warmer, the face becoming flushed, the thermometer ceasing to rise, and the skin beginning to act. Finally there is a rapid fall of temperature accompanied by profuse perspiration, which leaves the patient more or less exhausted.

Pus and its Constituents.—Normal, or as it was formerly called healthy, or laudable pus is a thick, creamy fluid, having a specific gravity of about 1030, an alkaline reaction, no smell (unless putrefying or under special circumstances), and containing 85 to 90 per cent. of water. If allowed to settle, it separates into two layers, the upper or fluid part, *liquor puris*, consisting of liquefied tissue and serum, whilst the lower layer contains the solid elements present, viz., dead and living pus corpuscles, fatty and granular débris, perhaps micro-organisms, and possibly a few red blood cells. All the pus cells look alike when examined under the microscope on a cold slide; but if placed on a warm slide, a difference is soon noticed. Dead pus cells (Fig. 7) remain rounded in outline, coarsely granular, and show two or three nuclei, which become more evident on the addition of dilute acetic acid. The living pus corpuscles are fewer in number, and, though spherical at first, soon manifest amœboid movements; their protoplasm is finely granular, and the single nucleus is not readily observed; the proliferation of the nucleus is always an evidence of degeneration and approaching death. It must be clearly understood that both the living and dead cells are derived from the same sources, viz., principally from the extravasated leucocytes, but also possibly from proliferation of the fixed connective-tissue corpuscles of the part.

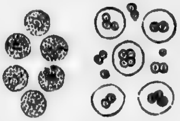

FIG. 7.—PUS CORPUSCLES BEFORE AND AFTER TREATMENT WITH DILUTE ACETIC ACID.

In the former the protoplasm is finely granular, and the nucleus not very evident; in the latter several nuclei are clearly shown.

As already stated, the pus in an acute abscess contains bacteria, which may best be demonstrated in the following way: A drop of pus is placed between two cover-slips, which are each evenly coated by a thin layer of the fluid by sliding one over the other. These are dried by passing them through the flame of a spirit-lamp, only sufficient heat being employed to set the albumin without destroying the corpuscles. A drop of methyl-violet solution is now placed over the pus film, and allowed to remain for about a minute, being then washed away by a stream of distilled water. The slip should be again dried slowly, and mounted in Canada balsam. The cocci will be found stained deeply, whilst albuminous and fatty granules are not coloured at all, or but slightly (Fig. 8). The arrangement of the cocci varies with the character of the suppuration. If the abscess is localized, they will usually be arranged in clusters (staphylococci, Fig. 2, VI.). If the suppuration is of a spreading type, or though localised very acute, they will occur in chains (streptococci, Fig. 2, V.).

Various terms are applied to different forms of pus which arise under special circumstances. When pus is mixed with blood, it is termed **sanious** (short for **sanguineous**); when thin and acrid, it is **ichorous**; **curdy**, when mixed with curdy shreds, as is more usually seen in chronic suppuration of a tubercular nature; **muco-pus**, when mixed with mucus, arising from inflammatory conditions of mucous membranes. The occurrence of **stinking** pus apart from putrefaction has been already explained as being due to the activity of the *Bacillus coli communis*.

The **Diagnosis** of an acute abscess, as a rule, presents no difficulties, the sense of fluctuation supervening in the midst of an area previously inflamed and brawny being quite characteristic; but when the pus is placed deeply under muscular and fascial planes, very careful examination may be needed in order to determine the existence of an abscess. The surgeon must not be misled by the sense of fluctuation obtained across the fibres of a muscle; none is noticed, however, by palpating along the course of its fibres.

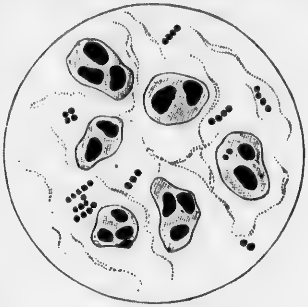
FIG. 8.—PUS FROM ACUTE ABSCESS, SHOWING CORPUSCLES AND COCCI.

Treatment of Acute Abscess.—When an inflamed area is threatening to suppurate, the formation of pus can be but rarely *prevented*. In the early stages, elevation and rest of the part, together with the application of cold and evaporating lotions, may sometimes succeed in accomplishing this, as also possibly the administration of sulphide of calcium in pills, with quinine and iron. The hypodermic injection of powerful antiseptics—*e.g.*, pure carbolic acid—has also been employed to destroy the pyogenic organisms *in situ*.

In a few regions of the body, pus may be *absorbed* after its formation, but only when situated in a cavity of highly-absorbing powers, such as the anterior chamber of the eye (hypopyon), or perhaps some of the serous cavities, *e.g.*, the peritoneal. In the former the process of absorption may certainly be observed under the influence of a simple local and general treatment.

As a rule, however, one encourages suppuration by applying hot fomentations to the part, and then as soon as pus is evident, an incision is made to *evacuate* the matter. In some cases it is advisable to anticipate suppuration by a free incision made under antiseptic precautions (*e.g.*, in acute periostitis); this has the beneficial effect of relieving tension, and often cuts short the inflammatory process. In incising an abscess, care must be taken that the opening is large enough to prevent re-accumulation, that it is placed at a spot suitable for drainage, as far as possible from sources of septic contamination, and in such a direction that movements of the part do not close it. The anatomy of the region incised must be remembered, and important structures avoided. In dealing with deep abscesses in dangerous regions, *Hilton's method* may be advantageously employed. It consists in merely dividing the skin and superficial structures, and then thrusting a director into the abscess cavity; a pair of sinus or dressing forceps is now passed along the groove, and on forcibly separating the blades a sufficient opening is made to insert the finger, where practicable, and subsequently a drainage-tube.

Methods of opening Various Abscesses.

Axillary Abscess.—Cut in the median line of the axilla towards the chest from above downwards, and use Hilton's method, thus escaping the three main sources of danger, viz., the axillary vessels above, the long thoracic in front, and the subscapular vessels behind.

Inguinal Bubo.—Make a vertical incision from below upwards, the patient standing erect against a wall or lying down. When he sits the incision gapes, and so accumulation is prevented.

Intramammary Abscess.—Cut in a direction radiating from the nipple to prevent injury to the galactophorous ducts, and pass a finger in so as to open up all the dilated lobules.

Retropharyngeal Abscess.—Incise along the posterior border of the sterno-mastoid for about an inch; draw that muscle and the carotid sheath forwards; open by Hilton's method, pushing a director inwards to the middle line immediately in front of the transverse processes.

Psoas Abscess or Iliac Abscess.—Incise the abdominal muscles just internal to and on the same level as the anterior superior spine, and open at that spot. In a few cases it may be advisable to open in the loin (Treves' method).

Empyema.—Open about an inch in front of the mid-axillary line in the fifth costal interspace, removing subperiosteally a portion of the fifth or sixth ribs, if necessary.

Ischio-rectal Abscess.—Place the patient leaning over the back of a chair, or in the lithotomy position if an anæsthetic is employed, and incise vertically and very freely as far from the anus as possible; healing may ensue without opening the rectum. In some cases where the skin is undermined, a crucial incision should be made, the resulting corners of skin being removed.

In opening a **Palmar Abscess**, care must be taken not to wound the superficial palmar arch or its digital branches. It is best accomplished by entering the knife immediately in a line with the centre of the metacarpal bones, cutting forwards to the base of the finger; the upper limit of this incision should not transgress the centre of the palm.

A **Whitlow** should be opened in the middle line of the finger by a knife held with its back towards the wrist, and it often happens that the patient, if conscious, unwittingly assists at his own operation by withdrawing his hand, thus effectually completing the incision; care must, of course, be taken not to let the knife travel too far or too deeply.

It is advisable to gently squeeze an abscess after opening it, especially when sloughs are present, or when it has burrowed; if the cavity is large, it should be explored with the finger. All that is needed subsequently, if there is no complication, such as the presence of dead or diseased bone, is to arrange for drainage, as by inserting a drainage-tube, or a slip of protective, and to exclude sepsis by a carefully applied antiseptic dressing; in other cases it may be desirable to pack the cavity with gauze soaked in an iodoform emulsion. There is often a considerable loss of blood during the first twenty-four hours from the yielding of the capillaries in the abscess wall, owing to the sudden relief of tension; but this usually ceases of itself, or yields to moderate pressure. *When once pus has been evacuated, no more is formed if the cavity is kept aseptic*, the discharge being merely serous, and the wound rapidly closing and healing. Under such circumstances bacteria are not found after twenty-four hours, being destroyed by the phagocytes. Pus which stinks on its evacuation, if not in open communication with the intestinal canal, will lose all smell in a day or two, the wound pursuing a normal course. In some cases the original opening at the spot where the abscess pointed may not give efficient drainage; a *counter-opening* should then be made by pushing the finger, or a probe, through the abscess wall amongst the tissues, making it protrude beneath the skin at some dependent spot, and cutting down upon the finger or probe in this direction.

Where acute diffuse suppuration is present with some tendency to sloughing, the application of warmth and moisture may with advantage be continued after incision; a boracic poultice (made by wringing boracic lint out of boiling boric acid lotion, 1 in 20), or a carbolic linseed poultice (made as an ordinary poultice, but with hot carbolic lotion, 1 in 30, substituted for water), will be found most useful. A charcoal poultice, dusted with iodoform, is occasionally advantageous when the parts are very septic, as after extravasation of urine.

Chronic Abscess (*syn.:* Cold or Congestive Abscess).

A chronic abscess may be defined as a collection of pus which forms slowly without any signs of active inflammation.. Although a few examples may be due to infection with pyogenic microbes or to chronic pyæmia, yet the vast majority are tubercular in origin; and, indeed, when a chronic abscess is spoken of, it may be taken for granted that it is tubercular, unless otherwise stated. Wherever tubercle can be deposited, a chronic abscess may form; but it occurs most commonly in connection with bones, joints, and lymphatic glands.

Into the details of these causative affections it is unnecessary to enter here; suffice it to state that the abscess arises from the degeneration of a tubercular focus without pain or inflammatory rédness; that it forms a soft fluctuating swelling, gradually increasing in size, and possibly by its pressure effects becoming painful; that it tends to come directly to the surface if there is no dense fascia to prevent it, but that, being usually placed deeply, there is a great tendency to burrow along fascial planes, and hence to become superficial at a spot far removed from its original source. Thus, an abscess arising in connection with tubercular disease of the dorsi-lumbar region of the spine may travel in many directions: it may pass backwards, and be opened at the side of the spine as a lumbar abscess; it may infiltrate the superficial fibres of the psoas muscle, and travel down the sheath to the groin, pointing either above or below Poupart's ligament; or it may find its way into the pelvis and escape either by the side of the rectum, or through the sacro-sciatic foramen into and along the thigh, and has even been opened at the side of the tendo Achillis (Fig. 9). The far-reaching extent of these abscesses, the impossibility of dealing adequately with the lining membrane, together with the infective nature of the disease, and the commonly inaccessible position of the original focus of the mischief, render them most difficult to treat, and fully account for the dread of opening them experienced by surgeons in pre-antiseptic days; for should the cavity of the abscess once become septic, there is but little hope of purifying it again, and the result will be an increased discharge of pus, absorption of the chemical products of putrefaction, aggravation of the original disease, and only too frequently death from exhaustion or blood-poisoning.

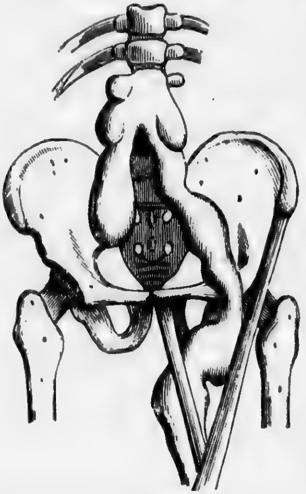

Fig. 9.—Psoas Abscess due to Disease of the Upper Lumbar Vertebræ. (After Albert.)

The method of extension along the psoas tendon and into the thigh is well seen.

The *pus* contained in a chronic abscess is usually characterized by containing, in addition to the ordinary constituents, masses of curdy débris of variable size and amount, consisting of coagulated fibrin with degenerated and fatty pus cells entangled in the meshes. If the abscess is one of long standing, an abundance of cholesterine crystals may be present, a fact recognised by the naked eye by the glistening sheen, or greasy appearance imparted to the pus; microscopically they appear in the shape of rhomboidal plates, with one corner notched out. It is unusual to find either cocci or bacilli in the pus of a chronic abscess, not even the specific organism of tubercle being discernible, and this in spite of the fact that inoculation of animals with the pus results in tuberculosis. Probably the bacilli have been broken up by the suppurative process, but the more resistant spores are still present.

The *microscopic appearance* of a tubercular *abscess wall* is quite characteristic. The cavity is lined by a layer of gray, yellowish-gray, or pinkish, pulpy granulation tissue, containing miliary tubercles perhaps undergoing caseation, and known as the *pyogenic membrane*. Its colour and vitality are dependent upon the chronicity or not of the process; the longer the abscess is in forming, the less vascular the membrane, owing to the associated sclerosis of the surrounding structures leading to compression of the blood-vessels, whilst it has been already mentioned that endarteritis always accompanies a chronic inflammation, and helps to render the parts non-vascular. This lining membrane is but loosely connected with a layer of fibro-cicatricial material, which forms the outer part of the wall, and from which it can usually be readily detached by the finger or a sharp spoon. This, in turn, gradually shelves off into the normal tissue which surrounds the abscess.

Natural Cure.—A tubercular abscess does not necessarily discharge itself. Occasionally in the dead-house one meets with a mass of putty-like consistency lying in front of the spine in the body of a patient who has been cured of spinal disease. This is evidently the desiccated remains of a chronic abscess, the fluid portion having been absorbed, and the solid elements left behind, encapsuled, and perhaps infiltrated with lime salts. Such débris can become the seat of recurrent inflammatory mischief when the original disease has been quiescent for years; an abscess may suddenly form and come to the surface, being then known as a *residual abscess*. Probably a large amount of cholesterine will be found amongst its contents.

Results of Long-continued Suppuration.—When a chronic abscess is opened antiseptically, and maintained in an aseptic condition, suppuration is, as a rule, of short duration; the wound may remain open for months, but the discharge will be merely serous, and no constitutional results will be manifested. The temperature remains normal, and the general health is unimpaired, if no other disease is present. But let such an abscess become septic, and the condition of affairs is at once changed; the discharge becomes purulent, fever supervenes, and grave visceral changes occur, which sooner or later may lead to the patient's death from exhaustion. *Long-continued suppuration, then, is always an evidence of sepsis*, and from it two conditions may arise, viz., hectic fever and lardaceous disease.

Hectic Fever may be defined as a chronic sapræmia or condition of blood-poisoning, due to the continual absorption of small doses of the ptomaines produced in septic wounds, and may be met with not only after opening chronic abscesses, but also in septic syphilitic or cancerous disease. It is characterized by a regular diurnal elevation of temperature, which runs a tolerably typical course. It commences to rise during the afternoon, the patient's face becoming flushed (hectic flush of the cheeks), the eyes bright and sparkling, the pupils dilated, and the patient feeling better and stronger. The pulse, however, is small, compressible, and ten or twenty beats quicker than it should be; the tongue becomes red at the edges and tip. This condition continues till late in the night, by which time the temperature may have risen four or five degrees. It then commences to fall as rapidly as it had formerly risen, and usually drops to the normal, or even below it, and in the early morning a profuse perspiration breaks out which soaks the patient's clothes, and leaves him in a much-exhausted condition. Day by day this continues, the fever and sweating together causing a marked diminution in the patient's strength.

Amyloid or Lardaceous Degeneration of various organs is also present in cases of long-standing suppuration. As to the cause of this curious condition, but little is known; either from the deleterious effects of septic compounds circulating in the blood, or from the loss of some special substance in the discharge, *e.g.*, alkaline phosphates, the walls of the smaller arteries and the protoplasm of certain of the viscera is converted into or infiltrated with a waxy substance, from which lardacein, an extremely insoluble proteid body, may be obtained. The name 'amyloid' is an entire misnomer, as this material is in no way akin to starch. It is met with as a waxy homogeneous material, becoming a dirty brown on the application of tincture of iodine, and an inky blue when sulphuric acid is subsequently added. With methyl-violet the amyloid substance becomes ruby-red, whilst normal tissues are stained blue or indigo. The organs mainly affected are the liver, spleen, kidneys, and villi of the intestines, and the capillaries and muscular coats of the small terminal arterioles (Fig. 10, *b* and *i*) are the parts first attacked, the change gradually spreading to the parenchyma of the organ. The *liver* becomes evenly enlarged to a considerable degree, often reaching from the fifth rib to the umbilicus or lower; it is firm in consistency like indiarubber, painless, and waxy-looking on section. The arterioles and capillaries in the intermediate zone of the lobules are those first affected, but the cells themselves soon participate in the change. The glycogenic and bile-producing functions are naturally interfered with, so that the digestive process, and especially the power of absorbing fats, is impeded. The *kidneys* become similarly enlarged, the change commencing in the arterioles leading to the glomeruli (Fig. 10), but the capillaries and the tubal epithelium are also early affected. In this stage the urine is very abundant (from the increased filtration through

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the degenerated walls), pale, limpid, and containing a few hyaline casts and fatty cells; later on, when the tubules are more largely involved, there is less urine, with a higher specific gravity, and a considerable amount of albumin. The *spleen* increases in size, but not always to so great a size as the other viscera; the Malpighian bodies are the chief seat of the mischief. The capillaries in the *villi of the intestines* become lardaceous, and allow of an increased transudation of the fluid parts of the blood, resulting in diarrhœa;

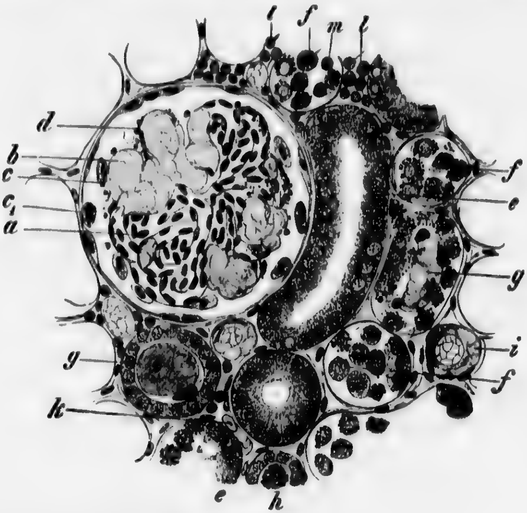

FIG. 10.—AMYLOID KIDNEY IN EARLY STAGE. (ZIEGLER.)

(Treated with Müller's fluid and perosmic acid. × 300.) *a*, Normal capillary loop; *b*, amyloid capillary loop; *c*, fatty epithelium of glomerulus; c_1, fatty epithelium of capsule; *d*, oil-drops on the capillary wall; *e*, fatty epithelial cells *in situ*; *f*, loosened fatty epithelial cells; *g*, hyaline coagula (forming 'casts'); *h*, fatty cast in section; *i*, amyloid artery; *k*, amyloid capillary; *l*, infiltration of connective tissue with leucocytes; *m*, round cells (leucocytes) within a uriniferous tubule.

the absorption of nutriment is thereby much lessened, and so both by increased excretion and diminished absorption of food the strength of the patient is steadily undermined.

Amyloid changes in the viscera, far from being a contra-indication to operation, are rather to be considered as a sign that radical treatment is urgently necessary, unless the general condition of a patient is such that he cannot stand the strain of it. If by a radical operation, *e.g.*, excision or amputation, the local disease can be eradicated, the amyloid changes in the viscera will totally disappear.

Treatment of Chronic Abscess.—In former days the rule always given was to leave a chronic abscess alone as long as possible, and never to interfere unless forced to do so; hectic and increased rapidity of the disease always followed such interference, even when Abernethy's valvular incision was employed. But when asepsis can be maintained, there is no reason to depart from the ordinary rule of surgery, that pus should be evacuated as soon as possible after its formation. It is, however, most important to recognise the fact that one slip in the technique may lead to a fatal issue, and therefore none should interfere with these cases unless they are prepared to take the time and trouble needed to keep them aseptic. From the risk, too, of sepsis being admitted during the dressing of the case, those methods should be preferred which admit of the immediate total closure of the wound. Many plans of treatment of chronic abscess have been suggested and practised; we can but epitomize the more important.

1. *Simple aspiration* has been known to effect a cure, but only in exceptional circumstances, viz., where the originating disease is absolutely passive, and where the patient's health and constitution are vigorous. It often fails from the blocking of the aspirator needle by curdy débris, and there is always a fear that much of this material will be left behind, forming a possible source of future re-infection. The rapid emptying of the sac, moreover, often leads to hæmorrhage, and the blood thus collecting will form a favourable soil for the development of the spores remaining in the curdy masses, or of the bacilli within the pyogenic membrane.

2. *Tapping the abscess with thorough irrigation* is another plan of treatment which under favourable circumstances is occasionally successful. We have seen both psoas abscess and empyema cured by one thorough washing out. The *modus operandi* is as follows: The skin is incised in one or possibly two separate places, and through these openings large trocars and cannulæ are inserted into the abscess cavity, which is emptied as completely as possible. It is now distended, by means of an irrigator inserted into one of the cannulæ, with warm solution of carbolic lotion (1 in 80), or with a sublimate lotion (1 in 5,000), or simply with sterilized water, at a temperature of about 110° F. The abscess is then well kneaded with the fingers, or the patient shaken from side to side, and then the fluid with the curdy masses and broken-down pyogenic membrane is allowed to escape. This process is repeated again and again until the escaping fluid is nearly clear, or only slightly opalescent. The cannulæ are now withdrawn, the wounds firmly stitched up, and an antiseptic dressing applied, using sufficient pressure to obliterate if possible the abscess cavity. The patient must be kept at rest, and carefully watched to ascertain if there is any reaccumulation, when the same process may be repeated.

3. *Opening the abscess and scraping out the interior* with Barker's flushing gouge is another useful plan, combining the irrigation of the previous method with the more or less complete removal of the tubercle-containing pyogenic membrane. The instrument employed consists of a gouge or sharp spoon with a long hollow handle, which communicates by a tube with a reservoir of fluid placed at some height above the patient. During its application the constant rush of water or lotion through the handle clears the gouge, and removes the débris. It is admirably adapted for certain cases, but its use needs considerable care, as the sharp edge can readily scrape through an abscess wall, and

do much mischief. It is a convenient means of dealing with abscesses of bones and joints in the more superficial parts of the body. The wounds should be subsequently closed, and an attempt made to gain immediate healing of the denuded cavity.

4. *Injection of an antiseptic into the sac after tapping* is a method introduced by Professor Velpeau in France, and has been received with much favour by some surgeons. Various reagents have been employed, but the majority have contained iodine either in the form of the tincture, or as iodoform, which latter may be suspended in glycerine or olive-oil (10 per cent.), or dissolved in ether (5 per cent.). The method of introducing these compounds is quite simple, the amount varying, but as a rule not more than a drachm of iodoform should be used. When the ethereal solution is injected, the ether immediately volatilizes and fully distends the abscess cavity, which becomes tense and tympanitic. It should on that account never be used for abscesses communicating with the interior of the thorax, death having in one or two recorded cases resulted from heart failure, due to such distension. There is some danger, too, that serious toxic symptoms may arise from absorption of the iodoform. Many cures are reported from this treatment, which is one of the best and safest that can be adopted. It is most likely to be efficacious when all active bone or joint disease has disappeared, and is most frequently employed as an adjunct to one of the above-described plans.

5. If the above methods fail, or are for any reason inapplicable, the original antiseptic method of *simple incision with drainage* can always be adopted. This is perfectly safe, so long as asepsis is maintained; but the great objections to it are the length of time often required to bring about healing, especially in cases where, although a free incision is made, the actual seat of the disease is not reached, and the consequent risk of contamination during one of the repeated dressings that are required. Months, and even years, are sometimes needed to gain this end, especially when a large psoas abscess is being dealt with.

6. In certain cases of external chronic abscess, it may be possible *to dissect out the whole cavity en masse*, and if such is feasible, it is the most satisfactory plan to adopt. It is especially applicable to chronic tubercular abscesses of lymphatic glands. Should the posterior wall of the cavity be adherent to important deep structures, it should be thoroughly scraped so as to remove all pyogenic material, and disinfected, *e.g.*, with solution of zinc chloride (40 grains to 1 ounce). An attempt may then be made to gain healing by first intention, or the cavity may be stuffed and allowed to granulate.

7. Laying the cavity freely open, scraping away the pyogenic tissue, perhaps purifying with pure carbolic acid, plugging the wound firmly with gauze infiltrated with purified iodoform, and allowing it to granulate from the bottom, or the *open method*, may be used advantageously in cases where abscesses have burrowed between muscles, and along fascial planes. Sulphur has also been used instead of iodoform, but has no special advantage, whilst it causes a good deal of sloughing of the surrounding tissues owing to its transformation into sulphurous, and finally into sulphuric, acid. Friar's balsam is another agent which may be employed in the same way, and is innocuous and useful.

Sinus and Fistula.

When an abscess has been opened, and does not completely heal, a communication often persists between the original seat of the disease and the exterior, which is known as a sinus or fistula. A **Sinus** is a narrow track lined with granulations, penetrating into the tissues, open at one end and closed at the other; the discharge is purulent or merely serous according to whether or not sepsis is present. A **Fistula** is an abnormal communication between two cavities, or between a cavity and the external surface. When such conditions result from the non-closure of a chronic abscess, the walls consist of exactly the same structures as those of the original abscess, viz., an external fibro-cicatricial vascular layer, merging into healthy tissues, and an internal lining of pyogenic membrane containing tubercles, if the originating disease was of this nature. If the fistulous track is short, there is a tendency for the granulating wall to become covered with epithelium, and under such circumstances it cannot be expected to close until the epithelium has been removed, and a raw surface again exposed.

It is often a matter of the greatest difficulty to secure the healing of a sinus or fistula, and the following are the main *causes of their non-closure:* (1) The presence of some chronic irritant in the depths of the wound, such as a piece of the clothing, a catgut ligature, a piece of silver-wire used in an operation, or of some diseased tissue, such as a fragment of dead or carious bone; (2) the irritation of discharges finding an exit through the abnormal opening, such as urine, fæces, or fœtid pus; (3) insufficient drainage of a deep cavity, so that there is always a certain amount of tension in the wound; (4) want of rest to the part, due either to voluntary movements, as in the limbs, or to involuntary muscular action in the immediate neighbourhood, as in fistula in ano; (5) tubercular infection of the wall, or a tubercular deposit at the bottom of the sinus; (6) constitutional debility.

The orifice of a sinus is often depressed from the amount of infiltration around, but in cases where foreign bodies are lodged within, or where diseased bone exists, it is usually surrounded by prominent fungating granulations.

Treatment.—The removal of the cause is the first thing to accomplish in dealing with a sinus or fistula. The passage must be dilated or slit up to allow of access to the deeper parts of the wound, to remove any foreign body which may be present, or to allow of the satisfactory drainage of a deep cavity. The making of a dependent counter-opening often suffices to cure a sinus. A thorough purification of the part by pure carbolic acid or chloride of zinc must also be undertaken, and the wound dressed by plugging with suitable material and kept at rest, whilst the general health of the patient is improved by tonics. Occasionally, the pressure of a roller bandage to immobilize the part is all that is required, or the application of a suitable splint. The most complete and certain method is to lay the sinus open, and thoroughly destroy the lining granulation tissue by scraping or cauterising, and then to plug the wound, allowing it to heal from the bottom by granulations.

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The term 'fistula' is also applied to conditions other than those tracks remaining from the non-closure of an abscess. Three classes may be described :

1. *Congenital fistulæ, e.g.*, branchial, umbilical urinary or fæcal, etc.

2. *Traumatic fistulæ, e.g.*, aerial, pharyngeal, salivary, recto-vesical, recto-vaginal, etc.

3. *Pathological fistulæ*, or those secondary to abscess or disease, *e.g.*, biliary, fæcal, perineal urinary, fistula in ano, etc.

Each of these will be referred to later on under its appropriate heading.

CHAPTER III.

ULCERATION.

Ulceration has been defined as the 'molecular or particulate death of a part,' by which is meant the disintegration of the superficial tissues, which liquefy and disappear, as a rule, without any obvious slough. It differs from gangrene in that the latter term is used to denote the simultaneous loss of vitality of a considerable portion of tissue. The two processes are, however, often so closely associated that it is impossible to draw a hard-and-fast line of distinction between them. In short, both ulceration and gangrene signify tissue necrosis; in the former the dead particles are not always visible to the naked eye, whereas in the latter the necrotic portions can always be seen.

As to the **Causes** of ulceration, but little need be added here to what has already been written as to the ætiology of inflammation generally (*vide* Chapter I.). Practically, the process is due to the application of an irritant to the surface of such an intensity, and for such a period, as to lead to local inflammation resulting in the destruction of the tissue affected. Any form of irritant, whether chemical, thermal, physical, or infective, may accomplish this end, and all the factors predisposing to inflammation will hasten its occurrence. Thus, faulty nutrition, whether from anæmia or from long-standing congestion, is particularly likely to further the ulcerative process. Moreover, when any part becomes anæsthetic, or is cut off from its trophic centres, the continued presence of an irritant may not be appreciated, and hence destructive inflammation occurs, *e.g.*, corneal ulcer following section of the fifth nerve, or perforating ulcer of the foot in tabes. In malignant disease the projection of the mass of the growth may expose it more than usual to irritation; but the chief cause of ulceration is the replacement of the deeper layers of the skin or mucous membrane by the cells of the neoplasm, so that when the superficial epithelium wears off or is lost it cannot be reproduced.

There are three main **classes** of ulcers:

(*a*) *Simple inflammatory ulcers*, *e.g.*, the spreading, healing, chronic, etc.

(*b*) *Infective* or *specific ulcers*, *e.g.*, soft chancre, lupoid, tubercular, syphilitic, etc.

(*c*) *Malignant ulcers*, *e.g.*, rodent, epitheliomatous, scirrhous, and fungating.

(*a*) Simple Inflammatory Ulcers.

Clinical History.—Every ulcer of this class tends sooner or later to recovery, and so may be said to pass through three stages, viz., (1) that of ulceration proper, or extension; (2) a stage of transition, or preparation for healing, which may be short or long, according to whether the ulcer is running a rapid or a slow course, and persists until the surface is covered with granulations; and (3) the stage of healing or repair. It must be clearly understood that the first stage alone represents the true ulcerative process; when this ceases, the ulcer proper has disappeared, and merely a superficial loss of substance, the result of the preceding ulceration, remains. If every simple ulcer passes through these three stages, then *every variety of simple ulcer must necessarily be in one of the three stages*, and hence may be described as a modification of a typical condition representing the stage to which it belongs. Necessarily, in a large ulcer the three stages may coexist, or a healing ulcer may from intrinsic or extrinsic causes relapse again to the stage of tissue destruction.

Stage I.: Ulceration Proper, or Extension.—The special characteristic of all ulcers in this stage is that destructive changes are still continuing with greater or less rapidity.

Naked-eye Appearances.—*Surface*, covered with ashy gray or dirty yellow material, partly slough, partly lymph, partly breaking-down tissue; no granulations are present; *discharge*, considerable in amount, thin, sanious, and often irritating and offensive, rarely purulent; *margins*, thickened and inflamed, and the surrounding tissue often œdematous and infiltrated; *edge*, sharply cut and well defined; the *base* of the ulcer tends to become thickened and fixed to the underlying structures.

Microscopically, all the phenomena of inflammation may be seen progressing to thrombosis and tissue necrosis, so that in approaching the surface of the ulcer from the healthy tissue around one would pass through zones of active hyperæmia, of retarded blood-flow with infiltration of leucocytes and plasma, of stasis and thrombosis, whilst the tissues are in a state of coagulation-necrosis.

Four different forms of ulcer in this first stage have been described:

The **Spreading Ulcer** is a term given to any ulcerative process which is progressing without visible portions of slough being cast off.

The **Sloughing Ulcer** is one in which definite portions of dead tissue are separated as sloughs. Such a condition results either from the action of an irritant of great severity, or from the low vitality of the tissues attacked.

The **Inflamed Ulcer** is one in which the inflammatory signs are well marked from the commencement, or in which from the supervention of fresh irritation, usually mechanical or septic, a healing process is replaced by a destructive one.

The **Phagedenic Ulcer** is one in which destruction occurs very rapidly, and is usually associated with sloughing. Formerly it was very common as one of the varieties of wound infection, the result of bad hygiene and insanitary surroundings in hospitals. Nowadays such a condition is never seen, having been entirely stamped out by antiseptics. Phagedena is at present only met with in venereal disease, and is the result of irritating discharges pent up behind a long foreskin, in a dirty, careless, and usually debilitated individual. If neglected, it may spread with great rapidity, and destroy a considerable portion of the penis. For full description and treatment, see Chapter XXXVIII.

Treatment of First Stage.—This resolves itself into removing the cause, protecting the surface from all sources of mechanical irritation, and purifying it from all septic contamination. The inflamed part must be kept at rest, and if necessary raised from a dependent position (*i.e.*, the leg must not be allowed to hang down), whilst the sore is dressed with moist and warm antiseptic applications, such as a boracic poultice. When the parts are very offensive, a charcoal and linseed-meal poultice may be first employed. The state of the bowels and constitution must be attended to, and probably a mild purgative will be needed. Under such a regime healthy repair is as a rule soon established.

Stage II.: **The Transition Period** comprises all the changes which occur from the termination of the ulcerative process proper to the time when healing is fully established by the wound becoming covered with granulations. In short, it may be described as the stage of *preparation for healing*.

Naked-eye Appearances.—When the destructive process has ceased, and the septic element has been eliminated, the surface of the ulcer begins to clean, and becomes, as it were, glazed over; sloughs and portions of dead tissues are either removed in the dressing or absorbed by the activity of the leucocytes and fibroblasts. The discharge becomes less abundant and more serous in character, and the angry red blush is replaced by a rosy hyperæmia. The infiltration and fixity of the base also diminish, so that the tissues around are more supple and pliable. The film on the surface becomes more and more defined, and in the course of time, shorter or longer, according to circumstances, little red spots begin to make their appearance here and there; these gradually increase in number and size, and coalesce, until the whole surface is covered by what has now become granulation tissue. The processes occurring in this stage are: (*a*) the removal of the sloughs; (*b*) the covering of the surface with a cellulo-plastic exudation; and (*c*) the vascularization of this exudation, and its conversion into granulation tissue.

Microscopic Appearances.—When the action of the irritant has ceased, the migration of the leucocytes lessens, and the destruction of tissue comes to an end. The surface of the ulcer now becomes covered with a layer of round cells, mainly derived from the proliferation of the neighbouring connective-tissue elements, and intermixed with fibrin in such a way that the cells lie in the interstices of the fibrillæ; this constitutes the film mentioned above. The vessels in the area, where merely stasis has occurred, become patent once more, and the circulation in the neighbourhood of the ulcer is thus restored. The vascularization of this superficial film is next undertaken, according to the process described in Chapter VII. The wound thus becomes covered with granulation tissue, and with its formation the processes included in the second stage come to an end.

All the forms of chronic ulcer which are neither spreading nor actively healing may be included in this transitional stage, viz., the indolent or callous ulcer, the irritable, the varicose, etc. They are most commonly seen on the legs of individuals whose occupation involves much standing; varicose veins commonly coexist, and the irritation of the skin by dirt and perspiration rubbed in from soiled clothes and filthy linen rags increases the mischief.

The **Indolent** or **Callous Ulcer** occurs most frequently on the lower legs of women about the middle period of life. The size varies immensely, but sometimes they are so extensive as to involve the whole circumference of the limb. They are also caused by burns on any part of the body where a large wound has been present. Healing proceeds to a certain extent, and then stops from the fact that the contraction of the cicatricial tissue already formed interferes with the vitality of the part still unhealed by compressing the vessels, and so cutting off the granulations from their source of nutriment. The *surface* is usually smooth and glistening, and of a dirty yellow colour, with perhaps a few badly-formed granulations; the *edges* are often hard and sharply cut, and elevated considerably above the surface, whilst the skin around may be heaped up over the edge, and either covered with sodden cuticle or congested. The skin of the limb is frequently deeply pigmented from chronic congestion, the pigmentation starting in the separate papillæ as maculæ, which gradually coalesce. The *discharge* is purulent or serous, and may be so abundant and irritating as to cause eczema of the parts around, and thus give rise to one form of *eczematous ulcer*. The *base* is adherent to the underlying tissues, fasciæ, etc.; and this constitutes one of the main difficulties in healing, as contraction of the sore is thus prevented. If the ulcer extends to the periosteum, as happens not unfrequently when placed over the shin, chronic periostitis, or even osteitis, results, and a subperiosteal node is formed, corresponding exactly to the size and situation of the ulcer, forming a mushroom-shaped node, and even possibly going on to necrosis.

The symptoms of this condition (as detailed in Chapter XVIII.) will accompany the ulcer.

The so-called **Irritable Ulcer** is usually met with in this stage. There is nothing very peculiar about it, except its position, usually in the leg, often over the ankle, and the pain accompanying it. The surface of a healing or chronic ulcer can usually be touched without the patient complaining: but in this variety the pain is excessive, especially at night. It was pointed out by the late Mr. Hilton that, if a probe is run lightly over the surface of such a sore, one or more spots will be indicated as the chief seats of the pain, the rest being insensitive. In all probability, nerve filaments are there exposed, as the pain has a very marked burning or shooting character.

The **Varicose Ulcer** occurs in the leg of a patient who is suffering from aggravated varicose veins. The skin becomes passively congested, and its nutrition is consequently impaired; any injury or abrasion, which would readily heal in a sound limb, is likely under such circumstances to give rise to a chronic sore. Again, it may be preceded by eczema resulting from the irritation of dirt or the friction of hard trousers, whilst occasionally it may result from the yielding of the thinned skin which forms the only covering of a much-dilated vein, an accident leading to severe hæmorrhage. The characters of a varicose ulcer vary considerably, but in the main they correspond to those of the second stage.

The **Treatment** of ulcers in this stage differs according to the conditions present. If it is merely a passing phase in the progress of an ulcer tending rapidly to repair, all that is needed is to continue the same course of treatment as was adopted at an earlier period of the case, viz., rest and protection from irritation. It may be advisable to shield the surface from contact with dressings by the intervention of a small portion of purified 'protective'—*i.e.*, oiled silk coated with dextrin—so that the reparative material may not be damaged during their removal.

The **Chronic Ulcer** needs much care in its treatment, and some cases require operative interference. Rest in a more or less elevated position is absolutely essential in order to relieve the congested condition of the limb; whilst if the surface is foul, a charcoal poultice may be beneficial, or it may be dusted over with iodoform, and boracic poultices applied. This may be preceded in some cases by touching the surface of the sore with nitrate of silver, or with a solution of chloride of zinc (40 grains to 1 ounce).

Pressure has been found of considerable service in the after-treatment of these ulcers; an ordinary bandage, reaching from the toes to the knee, will suffice in some cases, a suitable dressing of boric acid ointment, with perhaps some resin ointment added to make it more stimulating, being applied beneath it. *Martin's* indiarubber *bandage* is more serviceable when the veins are much enlarged; and where there is not much action, *Baynton's plan of treatment*, viz., strapping the limb and ulcer with adhesive plaster, may be advisable. The strapping must be laid on very evenly, and changed every forty-eight hours. If there is much discharge, holes must be cut in the plaster to allow of its exit, whilst antiseptic wool must surround the limb to prevent its becoming foul.

Of late years a new method of dealing with chronic ulcers has been suggested by Professor Unna, of Hamburg, and some excellent results have followed. It consists in the use of an adhesive plaster, made up as follows: Gelatine, 5 parts; oxide of zinc, 5 parts; boric acid, 1 part; glycerine, 8 parts; water, 6 parts. To this a little ichthyol or sulphur may be added. The limb is first thoroughly washed with soap and water, and purified with carbolic lotion (1 in 20). It is then wrapped round with a layer of antiseptic gauze, and the paste, heated so as to make it liquid, applied over the ulcer, reaching well above and below it. Where there is much varicosity of the veins, the paste should extend from the ankle to the knee, the foot being also included in some cases. Another layer of gauze is placed over the paste, and the whole allowed to dry. If there is much discharge from the ulcer, it should not be covered; but where it is but slight in amount, the paste may be carried right over it, and the whole application left in position for a week or two.

When the edges are very indurated and thickened, and all action is at a standstill, Syme's suggestion may be followed, viz., the whole surface, as well as the surrounding skin, is blistered, and then a suitable dressing applied. A more satisfactory method, but requiring an anæsthetic, is to thoroughly scrape the surface with a sharp spoon, and then to rub in a strong solution of chloride of zinc. This may be accompanied by some means of freeing the ulcer to allow of its contraction, such as Nussbaum's plan of incising the skin surrounding the ulcer at a distance of 1, 2, or 3 inches, and thus considerable space for contraction is gained. Should it be adherent to a thickened tibia, the base should be divided, and the exuberant new bone removed, but of course the surface must be thoroughly purified before doing this. As soon as healthy action is established, skin-grafting may be undertaken, if necessary.

Where varicose veins exist, treatment is of little avail unless these are efficiently dealt with either by operation or by some suitable support. Unna's paste often answers this purpose most admirably.

The **Irritable Ulcer** may be treated by discovering the painful spots, and incising the tissues just above them with a knife, so as to divide the exposed nerves. Scraping under an anæsthetic is, however, preferable.

The **Eczematous Ulcer** must be dealt with differently from the others, or the eczema will be aggravated. Soothing applications are needed, such as lead lotion, and when once the acute stage has passed, tarry preparations (liq. carbonis detergens, 1 ounce to a pint of lotio plumbi), or a solution of ichthyol (1 in 4 of water), may be beneficially employed. A mixture of benzoate of zinc and boric acid ointments is a very useful application. Unna's paste with ichthyol may also be applied.

Stage III : **Repair** having now been fully established, and an ulcer proper no longer existing, we have merely to deal with a healthy granulating wound, and to describe, not a healthy ulcer, for such a condition cannot exist, but a healing wound, the result of ulceration, or, as we may call it to avoid confusion, a 'healing ulcer.'

A **Healing Ulcer** is characterized by the following conditions: *Surface*, smooth and even, shelving gradually from the skin, and covered with healthy granulations; these present a florid red appearance, are painless, and bleed, but not readily, on being touched. The *discharge* varies according to the plan of treatment adopted: if the surface is kept free from all irritants, either septic or antiseptic, the discharge is merely serous; but should the wound become septic, or be dressed with irritating antiseptics, ordinary pus will be formed. The surrounding skin is soft, flexible, and free from inflammatory congestion; the *base* is similarly free from fixity; whilst the *margins* present a healing edge, which has been described as manifesting three coloured zones: within is a *red* area consisting of the granulation tissue, covered by a single layer of epithelial cells which cannot be seen except in a good light; next comes a thin dusky purple or *blue* line, where the granulations are covered by a few layers of epithelium, and the circulation is becoming retarded owing to cicatricial development; whilst outside is a *white* zone due to the heaping up of sodden cuticle upon the healthy or healed part.

Red
blue
white

The method of repair in such a wound consists in the change of the deep layers of the granulation tissue into fibro-cicatricial tissue, the contraction of this cicatricial tissue, and the covering of the surface with cuticle. For full description see Chapter VII.

Occasionally if emollient applications are used too freely and too long, the granulations become pale, protuberant and œdematous, and the healing process is temporarily checked. A depressed general condition of the patient, or a varicose condition of the veins, may also account for this, and the term *a weak ulcer* is applied to it, whilst the prominent flabby granulations are popularly known as *proud flesh*.

The **Treatment** of a healing ulcer is simple in the extreme. All that is needed is to keep the surface free from irritation, and Nature will rapidly bring about a cure. The limb, if such it be, must be kept at rest, and if the leg is the seat of the trouble, it must not be allowed to hang down. The wound is dressed with any simple unirritating antiseptic, and perhaps boric acid is as good as any; a piece of protective, the exact size of the sore, may with advantage be placed over the wound, or ointment spread on lint or gauze applied. If the granulations become too prominent, they may be lightly touched with nitrate of silver, and a more stimulating lotion applied.

Large ulcers require some assistance in order to obtain expeditious healing, otherwise a time will come when the contraction of the cicatricial tissue will interfere with the nutrition of the granulations, and henceforth the healing process is at an end. Various proceedings have been adopted to hasten matters, amongst them many of the plastic operations detailed in Chapter XXXIX., and also the different methods of skin-grafting.

Skin-grafting, or the transplantation of more or less of the thickness of the skin from a healthy to a healing part, was introduced by Reverdin in 1869, and has since been much elaborated. The following methods are employed:

1. Transplantation of small portions of the cuticle and cutis, Reverdin's original plan. A small portion of the cutaneous tissue is pinched up with or without forceps, and removed by a pair of sharp curved scissors. In thickness it should include the cuticle and a portion of the cutis vera, so that a drop or two of blood will slowly ooze from the denuded surface. The graft is then placed cutis downwards on the surface of the granulations of the wound, and covered with protective, purified in boric acid. Many of these may be applied at the same time, and the whole wound carefully dressed and protected. If there is much discharge, the grafts will not 'take': but if the wound is pure, and merely discharging serum, there should be no difficulty in getting them to grow. Usually they disappear for a day or two, from the cuticle becoming softened and disintegrated; but soon the epithelium of the cutis spreads, and makes itself visible as a distinct centre of repair. The greatest care is needed in handling the graft, otherwise it readily perishes.

2. Transplantation of large portions of cuticle as suggested by Thiersch. This method consists in removing large strips of cuticle and cutis vera with a razor, and implanting them on the surface of the wound previously denuded of all granulations. The ulcerated surface is usually first scraped, and the resulting hæmorrhage stayed by pressure with a sponge, a layer of protective being, however, interposed, so that when the sponge is subsequently removed the bleeding shall not recur. The strips of cuticle are then cut, care being taken to make them as thin as possible; they should be allowed to remain soaking in the exuded blood until required for use. When it is thought that sufficient material has been thus obtained, the sponge and protective are removed, and the grafts gently transferred, being applied in such a way that they overlap each other, and also the margins of the defect. There is always a considerable tendency for the edges of the grafts

to turn in, and this must be prevented. They are then covered with protective, or thin silver-paper, and the whole dressed antiseptically. There is usually no need to look at the wound for some days. The outer sides of the thigh or upper arm are the best places from which to take the grafts. Exactly the same method may be adopted in dealing with fresh wounds where the skin covering is deficient, and thus subsequent contraction may be to a large extent prevented.

3. The whole thickness of the skin may be used in some instances. Thus, the preputial tissue removed in circumcision is most valuable for this purpose, being soft and flexible. All redundant and fatty tissue must be removed, and *only* the skin applied. The granulations should always be previously scraped away, and the graft stitched down to the cicatricial tissue below with fine catgut. It may also be applied to the raw surface of an operation wound. For the details to be observed in this proceeding, see the general rules of plastic surgery laid down in Chapter XXXIX.

4. The skin of animals, such as frogs and young rats, has been employed with success in some cases; but it is just as easy, and much more satisfactory, to make use of human skin for this purpose.

5. Another plan that has been suggested consists in 'sowing' the surface of the granulations with the epithelial débris removed by vigorous scraping of a healthy portion of the skin.

(*b*) Infective Ulcers.

The different forms of infective ulcers met with in surgical practice will be described under the appropriate headings in different parts of the book. It will suffice here to mention them :

Soft Chancre (Chapter XXXVIII.).—This may be taken as a type of all infective ulcers, clearly showing the stages of infection, incubation, ulceration, and repair.

Ulcers due to Syphilis (Chapter XXXVIII.) :

(*a*) The primary sore.
(*b*) Secondary ulcers, mainly of mucous membranes.
(*c*) Intermediate, rupial, or ecthymatous sores.
(*d*) Tertiary ulcers from the disintegration of gummata, either superficial and multiple, or deep and single.

In inherited syphilis, any or all of the above varieties may be seen, except the primary sore.

Ulcers due to Tubercle :

(*a*) The lupoid ulcer, due to a cutaneous tuberculosis (p. 124), or
(*b*) The tubercular ulcer, arising as a rule from the bursting of a subcutaneous or submucous tubercular abscess (p. 127).

(*c*) Various other tubercular ulcerative lesions of the skin are described by dermatologists under the title 'scrofuloderma,' whilst Bazin's disease (or erythema induratum) is also possibly tubercular in origin.

Malignant Pustule, due to the *Bacillus anthracis* (p. 118).

(*c*) Malignant Ulcers.

These are due, as has already been pointed out, not to any inflammatory process, but to the actual replacement of the skin by the growth, so that loss of substance necessarily ensues. It is only requisite to mention the varieties here; a fuller description will be appended later (Chapter VI.):

(*a*) Rodent ulcer, a chronic cancer starting in the sebaceous glands or hair follicles, and accompanied with very little overgrowth.

(*b*) Epitheliomatous ulcer, arising from cancer of the skin or mucous membranes.

(*c*) Scirrhous ulcer, resulting from destruction of the skin over a scirrhous tumour.

(*d*) Fungating ulcer, where a neoplastic growth protrudes from the skin. It may be caused by a soft encephaloid cancer, or a sarcoma, whilst a cysto-adenoma mammæ gives rise to a similar appearance. It constitutes the condition formerly known as a 'fungus hæmatodes.'

One or two ulcers remain to be mentioned, the characteristic appearances of which are due, not to any special modification of the ulcerative process, but to some general or local condition which leaves its marks upon the sore.

Perforating Ulcer of the Foot is a term applied to an affection met with (1) in certain central nervous diseases, such as tabes dorsalis, syringomyelia, spina bifida, etc., in which the sensitiveness of the soles of the feet is diminished, so that the patient cannot appreciate any slight trauma directed towards them; (2) it arises in a similar way in diseases, such as diabetes, syphilis, alcoholism, etc., which lead to peripheral neuritis; and (3) may also follow traumatic lesions of the nerves; (4) it is occasionally due to pure plantar lesions, apart from any nervous influence, *e.g.*, a suppurating wart or corn, or even a chronic epithelioma. The ball of the great toe is the part most frequently affected, but any spot to which undue pressure is directed may become involved, and not infrequently several such sores may be seen on the same foot. A corn or callosity first forms, and under this a bursa, in which suppuration takes place, the pus tending to travel not only to the surface, but also deeply, so as to involve bones and joints. A typical perforating ulcer presents the appearance of a sinus passing down to the deeper parts of the foot, the orifice of which is surrounded by heaped-up and thickened cuticle. There is usually but little discharge and often no pain. Left to itself, considerable destruction of the bones and joints of the foot may be caused, necessitating amputation; but if taken in hand early, a cure can be established by carefully paring away the thickened mass of cuticle, purifying the sinus, and protecting the parts from pressure, at the same time that measures are directed towards the cure of any nerve lesion present.

A **Scorbutic** or **Hæmorrhagic Ulcer** is one characterized by a tendency to the discharge of blood from the surface; the granulations are always of a dusky purplish appearance, and are prominent and almost fungating.

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CHAPTER IV.

GANGRENE.

By gangrene is meant the simultaneous loss of vitality of a considerable area of tissue. If the process is limited to the soft parts of the body, it is often termed *sloughing* or *sphacelation*, and the dead mass a *slough* or *sphacelus ;* if a tangible portion of bone dies, *necrosis* is said to have occurred, and the necrosed mass is called a *sequestrum ;* whilst the term *gangrene* is more especially applied to a necrotic process affecting simultaneously the hard and soft tissues of a limb.

General History of a Case of Gangrene.

Signs of Death.—Death of a limited portion of the body can be recognised prior to the supervention of evident post-mortem changes within it by five characteristic signs :

1. Loss of pulsation in the vessels.
2. Loss of temperature, since no new warm blood is brought to it.
3. Loss of sensation in the dead part, although much pain may be experienced whilst death is occurring, and such may be referred to the dead part through irritation of the nerves above.
4. Loss of function of the gangrenous mass, which, if it is a limb, lies flaccid, motionless, and helpless.
5. Change of colour, the character of which depends on the amount of blood in the part at the time of death ; if the limb is full of blood, it becomes purple and mottled ; if anæmic, a waxy or cream colour results.

These five signs may be in measure present when the vitality of a limb is merely seriously depressed, as by ligature of the main vessel or by its embolic obstruction ; but if they continue for any length of time, death is practically certain to ensue, and they will then be rendered more obvious by the phenomena about to be described.

Changes occurring in the Dead Tissues.—The character of these changes depends mainly on the condition of affairs at the time of death, and whether or not putrefaction occurs. The following conditions are described :

1. **Dry Gangrene** (= *death* + *mummification*).—Such can only occur when the tissue involved is, previous to its death, more or less drained of its fluids, so that it readily shrivels up and loses its moisture. The usual cause is chronic arterial obstruction, as brought about by atheroma or calcification of the terminal arteries, to which usually a sudden or gradual complete occlusion of the main trunk is superadded. The dead part becomes hard, dry and wrinkled, and is of a dark-brown or black colour from the diffusion of the disintegrated hæmoglobin (Fig. 11). The more fleshy parts may, however, retain a certain amount of moisture. Septic troubles rarely involve the dry dead tissue itself, but the surrounding living tissues are often considerably affected.

2. **Moist Gangrene** arises when a part of the body full of fluid dies, and is especially associated with any obstruction on the side of the veins, or with acute arterial thrombosis in a previously sound limb, *e.g.*, in traumatic gangrene due to pressure upon, or rupture of, the main trunk. The loss of the *vis a tergo* derived from the heart's impulse causes a negative pressure in the capillaries, which become filled by regurgitation from the veins. Obviously, such a condition is admirably suited for the development of putrefactive organisms, which always exist in numbers on the skin, and unless the most vigorous efforts are made to render it aseptic before or immediately after death, moist gangrene is certain to be associated with putrefaction. Unhappily, this precaution is but seldom adopted, or even available, and hence in the majority of cases putrefaction occurs; it must be clearly understood, however, that it is no essential part of the process.

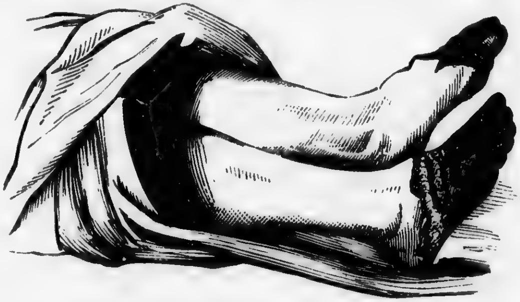


FIG. 11.—SENILE DRY GANGRENE, AFFECTING BOTH FEET.

Aseptic Moist Gangrene is characterized by the dead tissues becoming more or less discoloured, either purple or any shade from black to yellow, green or white. It remains of much the same size and consistency as at the time of death so long as it is kept from contamination, and is then simply and quietly cast off from the surrounding tissues without any obvious inflammatory disturbance.

Septic or Putrid Moist Gangrene (Fig. 12) is necessarily associated with a rapid breaking-up and disintegration of the mass, which becomes black, green, or yellow. The cuticle is raised from the cutis vera by blebs containing stinking serum, or even bubbles of gas, and these are readily pressed along under the epidermis for some distance. The tissues of the limb are soft and lacerable, and on grasping it emphysematous crackling is readily noted.

The **Later History** of a gangrenous mass depends entirely on the asepticity or not, and on the size of the dead tissue.

(*a*) If the necrotic area is small in size and aseptic, it may, under favourable circumstances, be entirely *absorbed* in exactly the same way as a catgut ligature is dealt with. Such may be often observed after sloughing of small portions of amputation flaps; if the part is kept dry and aseptic, it is gradually removed from below, and when the process is completed, a small dark scab will fall or be picked off, and a cicatrix found beneath it. In an exactly similar way dead bone may be absorbed, if the sequestrum is not too large or too dense, and if it is in close proximity to healthy vascular tissue. Thus, a child came to the hospital with a portion of the outer table of the skull, as large as the palm of a man's hand, quite bare and dead, as the result of a sloughing cellulitis; it was treated antiseptically, and we gradually saw granulations springing up through the bone in all directions, and finally the whole was absorbed, with the exception of merely a small flake, the size of one's little finger nail, which separated. The dead portion is first invaded by leucocytes from the lymphatic spaces or vessels of the immediately contiguous living tissues, and infiltrated by them and the accompanying blood plasma. By a process of auto-digestion this infiltrated portion disappears, and is replaced by granulation tissue. This process of removal and replacement is continued until the whole of the dead tissue disappears, and the resulting mass of granulation tissue becomes

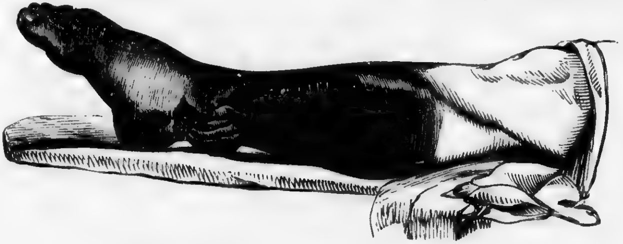


FIG. 12.—SEPTIC MOIST GANGRENE OF LEG.

converted into a cicatrix, and covered with cuticle in the usual way.

(*b*) If the mass, though aseptic, is of such a size, or consists of such tissues, as to prevent its total absorption, or if the vital activity of the patient is lowered, a modification of the same process results in *partial absorption* of the dead material, *whilst the remainder is cast off and separated by a simple process of anæmic ulceration.* The dead part immediately contiguous to the living is removed and replaced by granulation tissue, and this change continues advancing into the mass until the layer of granulations which has penetrated furthest is at such a distance from its nutritive basis as to be unable to derive from it sufficient pabulum, owing to the contraction of the cicatricial tissue which is forming behind; and then a simple ulcerative process from defective nutrition causes a line of cleavage to form between the living and dead, by means of which the latter is separated from the body. The size of the portion cast off from the body is thus distinctly less than the area of original necrosis. Whilst this is occurring, there is no local inflammatory reaction, and no resulting constitutional disturbance. It is slow in progress, but there are none of the risks attaching to the more rapid septic proceeding. Of course, the denser and harder the tissues, the longer they take in separating.

(*c*) If the gangrenous portion is septic, its *separation* is accomplished *by a distinctly inflammatory act taking place in, and at the expense of, the surrounding living tissues.* The extent of the gangrene is primarily indicated by a *line of demarcation,* due to the change in colour occurring in the dead part, the living tissues retaining their normal hue. But the irritation of the chemical products formed in the necrosed mass causes in a few days inflammation in the surrounding structures, resulting in hyperæmia and subsequent exudation of plasma and leucocytes; the tissue of the part disappears, and is replaced by a cell infiltration, which in turn breaks down into pus, whilst a layer of granulation tissue forms at the limit of the living portion, and thus the *final line of separation* is produced. Clinically, one notices in the earliest stage a bright red line of hyperæmia at the extremity of the living tissue, and this gradually spreads and deepens until about the eighth or tenth day, when, if the cuticle is intact, the living and dead parts are separated by a narrow white or yellow line, which is proved, on pricking the epidermis, to be due to the presence of a layer of pus; as the pus escapes, a shallow groove is seen, running between a granulating surface on the side of the living tissue and the gangrenous mass. This process, gradually extending through the whole thickness of the limb, is attended by the local signs of inflammation, viz., local pain and fever, the amount of which depends on the amount of putrid material absorbed. The inflammatory process, moreover, is not always limited to the line of separation, but may spread upwards along the lymphatics, or in the fascial and muscular planes, until, perhaps, the whole limb may become involved in an extensive suppurative process.

Constitutional Symptoms of Gangrene.

These may be described under two distinct headings:

(*a*) Those general conditions which predispose to the occurrence of gangrene. These are mainly of a debilitating character, affecting either the composition of the blood or the vitality of the limbs. Thus, the patient may be suffering from general asthenia, such as results from preceding fevers; or his circulation may lack vigour either from weakness of the heart muscles or from some valvular lesion; or, again, his arteries may be so diseased, or rendered so rigid by atheromatous or calcareous changes, that, although a sufficient supply of blood may reach the extremities for all ordinary circumstances of life, yet any unusual demand upon the circulation cannot be met. Many evidences of such malnutrition usually manifest themselves before the onset of gangrene. General diseases, such as diabetes and albuminuria, may also be present, whilst the constitutional evidences of a vicious life may be seen.

(*b*) Those conditions depending on the presence and connection with the body of the dead tissue. Various forms of septic or ptomaine poisoning result from this, usually causing fever, asthenic in type and variable in amount. Pain, moreover, is frequently a very prominent feature in some forms of gangrene, and even if the patient is protected by the surgeon's care from the dangers of sepsis, yet he is sometimes liable to become exhausted from this cause.

Treatment of Gangrene.

This naturally divides itself into the local and general. We shall not discuss the question of **Local** treatment here, leaving it to be dealt with under the appropriate headings hereafter. As to **General** treatment, but little needs to be said beyond that the strength of the patient must be maintained by plenty of easily assimilable food, sufficient stimulant, and tonics. Pain and sleeplessness must be combated by the administration of a suitable amount of opium or morphia, if the kidneys are healthy. Diabetes and albuminuria need dietetic and therapeutic measures in order to limit, if possible, the excretion of sugar and albumin.

Varieties of Gangrene.

Having thus traced in outline the general history of a case of gangrene—the signs of death in the part, the various post-mortem changes which may occur in it, the means whereby Nature rids the body of such an encumbrance, and the various dangers, local and general, the patient runs—we now turn to the different forms of the disease which are met with, and propose to discuss them *seriatim*. The following classification is one which, though admittedly imperfect, does in a measure group together allied types of the affection, and will serve as a useful one for practical purposes.

I. **Idiopathic Gangrene**, or that predisposed to by preceding vascular or general conditions, or where a trauma, if present at all, is of very slight significance compared with this pre-existing disease.

(*a*) Gangrene from embolus.
(*b*) Raynaud's disease.
(*c*) Gangrene due to ergot.
(*d*) Diabetic gangrene.
(*e*) Senile gangrene.

II. **Traumatic Gangrene**, which may be due to direct or indirect injury, and where the damage done to the vessels or tissues by the trauma is the immediate cause of the loss of vitality. Two varieties of this may be met with, viz.:

(*a*) The indirect, where the lesion involves the vessels of the limb perhaps some distance above the spot where the gangrene occurs.
(*b*) The direct, where the gangrenous process is limited to the part injured.

III. **Specific or Infective Gangrene**, which arises from the activity and influence of micro-organisms.

(*a*) Acute inflammatory or spreading traumatic gangrene.
(*b*) Wound phagedena and hospital gangrene.
(*c*) Necrosis of bone (most cases).
(*d*) Noma and cancrum oris.
(*e*) Carbuncle and boil.

IV. **Gangrene from Thermal Causes**—frost-bite and burns.

Each of these varieties must now claim separate and individual attention.

I. Idiopathic Gangrene.

(*a*) **Embolic Gangrene**. (For general details as to emboli, see Chapter X.) When the main artery of a limb becomes blocked by a simple embolus, the condition of affairs is exactly similar to that which obtains after ligature—*i.e.*, the vitality of the part is diminished until such a time as the collateral circulation is established. Under ordinary circumstances, then, it should not give rise to gangrene; but if either the general or local vitality is much reduced, the obstruction of the main trunk may be just sufficient to determine the death of more or less of the limb. There are two chief conditions under which gangrene is likely to follow an embolus: (i.) Where the embolus consists of a fibrinous vegetation detached from one of the cardiac valves in a case of endocarditis following rheumatic or other fevers. The general nutrition has been depressed by the preceding fever, the heart's action is weak, and the circulation possibly impeded by the valvular lesion, so that the block of a terminal main trunk, even in a young person, is often sufficient to determine gangrene. (ii.) It also follows when a detached atheromatous plate blocks the main vessel of a limb previously rendered anæmic by arterial degeneration, an occurrence occasionally met with in elderly people.

The early **Symptoms** are alike in both conditions. Sharp pain is generally produced by the lodgment of the embolus, both at the point of impaction and also down the limb along the course of the vessel. Emboli are most commonly arrested at the points of division of the main trunks (Fig. 13, A), or where the calibre is suddenly diminished by the origin of a large branch, the embolus often saddling over the bifurcation, and thus, as it increases in size by the subsequent deposit thereon of fibrin, effectually closing both branches (Fig. 13, B). In the lower limb it occurs at the division of the femoral or popliteal; in the upper, at the origin of the superior profunda, or where the brachial divides. Pulsation in the vessels below the block ceases, sensation and temperature diminish, and the part feels heavy and useless. If the vessels are healthy, as in the first group of cases, regurgitation through the veins is the usual result, the terminal portion of the limb becoming congested and œdematous, and finally falling into a condition of moist gangrene. If, however, the terminal arteries are calcified or atheromatous, so that the limb is in a condition of chronic anæmia, this is not so likely to occur, and dry gangrene follows. The process starts peripherally, and spreads gradually upwards until a region is reached where there is sufficient circulation to maintain the life of the part. Such usually occurs in the neighbourhood of a joint, since there is always a more free anastomosis here than in the interarticular portions of the limb; thus, in the leg the gangrene is usually arrested either immediately above the ankle or

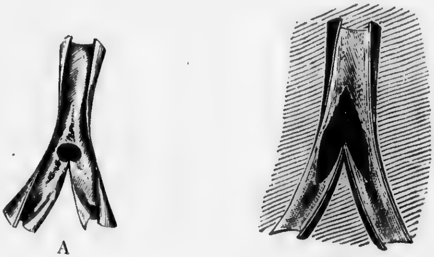


FIG. 13.—DIAGRAMS OF EMBOLUS SADDLING THE BIFURCATION OF AN ARTERY.

In A the embolus is seen, and the commencement of a thrombus on it, but not yet obstructing the vessel; in B both branches of the trunk are blocked by the growth of the clot.

below the knee. The subsequent history depends upon whether or not the dead tissue is allowed to become septic, and in no way requires special notice.

Treatment.—The all-important requisite in dealing with a case of this nature is to prevent the advent of sepsis, since it may transform what would otherwise be a condition associated with but little danger into one of the gravest moment. As soon as possible after the obstruction has taken place, and any absolute signs of death are manifest, scrupulous care must be taken to purify the part. The nails should be cut, and the whole limb thoroughly but gently scrubbed with carbolic lotion (1 in 20), special attention being directed to the intervals between the toes and the folds of skin under and alongside of the nails. It should then be wrapped in a layer or two of moist and purified gauze, swathed round with salicylic, iodoform, or sterilized wool, and lightly, though firmly, bandaged. The limb is kept slightly raised, so as to prevent venous regurgitation without interfering with the arterial supply, and by this means gangrene may be prevented. If, however, these precautions are not successful, and the part dies, the same measures as to the maintenance of asepsis must be continued until a natural line of separation forms. In old people with dry gangrene the same rules are followed as for the senile type; but in the moist form, occurring in young people, the natural process of separation may be hastened by severing the dead from the living, and sawing through the bone, or possibly amputation through the living tissues a little above may be considered advisable, a more shapely stump being thus obtained. Where sepsis has occurred it is advisable to amputate through healthy tissue as soon as a definite limit has been reached by the necrotic process. If, however, there has been much spreading septic inflammation, one may be driven much higher up the limb than would be otherwise necessary, whilst very acute septic symptoms may determine amputation before any line of separation has formed.

(*b*) **Raynaud's Disease, or Spontaneous Symmetrical Gangrene,** is a condition usually met with in young women between the ages of fifteen and thirty, who are of an anæmic, chlorotic, or nervous temperament. It is due to vaso-motor spasm, dependent either on some deep unrecognised lesion of the spinal cord, or in some cases to a peripheral neuritis. It occurs in conditions of nervous exhaustion, and has been known to be started by fright. Its onset is often sudden, and it may last for a variable time, from days to months. If gangrene supervenes, the latter is the limit more often reached, but it by no means necessarily follows that tissue necrosis occurs in every case. Three stages are usually described: (i.) local syncope or anæmia, arising as the direct result of arterial spasm, and characterized by pallor and painfulness of the part; (ii.) local asphyxia or congestion, in which the affected tissues are blue and cyanosed from venous regurgitation; and (iii.) finally the part dies, often becoming dry and black. The fingers and toes are most likely to become involved, the process starting by the side of the nail; but symmetrical spots on the back, trunk, thighs, legs, forearms, and arms, are also attacked, and more or less in that order of frequency. Fever does not accompany the process, but paroxysmal hæmoglobinuria has been observed, and is supposed to be due to a vaso-motor disturbance of the kidneys. Ankylosis of the smaller joints, and localized patches of anæsthesia, associated with pain of a neuralgic type, are also sometimes present, resulting from the peripheral neuritis. The condition somewhat resembles the later stages of a chilblain from its red and congested appearance, but is distinguished from it by its more dusky colour, the greater pain, the absence of itching, and the fact that the process is not limited to exposed or terminal parts, or to cold weather.

The **Treatment** must be in the first case preventive. The constitution should be built up by iron, quinine, and if need be by stimulants, whilst locally friction with stimulating embrocations, warm douches, and protection from cold and injury, must be employed. When actual gangrene is present, the dead tissue should be kept aseptic, when sooner or later it will be absorbed or separated.

(*c*) **Gangrene from Ergot** is a rare phenomenon, but it has been known to occur when diseased rye has been used in the manufacture of bread. The effect is to produce chronic anæmia of the extremities from contraction of the smaller terminal arterioles, but in addition peripheral neuritis and anæsthesia may supervene. Probably the gangrene is mainly due to the latter condition, the patient being unaware of injuries which, being constantly repeated, lead in an ill-nourished limb to death of the part. The resulting gangrene may vary in extent from the loss of one or two fingers or toes to the sacrifice of the greater portion of one or more limbs.

(*d*) **Diabetic Gangrene** is in part due to the abnormal condition of the blood present in diabetes, thereby reducing the power of the vessel walls and tissues to resist inflammatory changes; but is also in part the result of a sclerosing endarteritis and peripheral neuritis. It is not commonly met with in the subjects of malignant diabetes, nor, as a rule, in people below forty years of age. It results usually from some slight traumatic or infective injury, and commonly commences on the under side or at the extremity of one of the toes as a bleb, surrounded by a dusky purple areola. When the bleb is opened or bursts, the central portion of the underlying tissue is found to be necrotic, and from this focus the gangrene spreads, taking on a moist or a dry type according to the amount of vascular disease.

In the **Treatment** an attempt should be made to reduce the excretion of sugar by administering codeia and regulating the diet, but too much time must not be lost in this proceeding. A careful investigation of the condition of the vessels is called for. If they are tolerably healthy, removal of the dead tissue by an amputation not very much above the upper limit of the disease is justifiable; but should there be evidence that the main trunks are affected some way up, then either the separation of the necrosed mass must be left to Nature, the surgeon merely assisting by the division of bones, or, if the patient's general state is tolerably good, a high amputation may be undertaken. Under the latter circumstances, however, there is some risk of the supervention of the diabetic coma.

(*e*) **Senile Gangrene** is a condition which, as the name implies, occurs almost entirely in elderly people, and is the result of imperfect nutrition of the tissues. The toes are most frequently affected, but it is also seen in the hand, and may attack the nose, ears, or even the tongue.

Causes.—These are to be found mainly in the condition of the circulatory organs. (*a*) *Calcification or rigidity* of the smaller arteries of the limb or part is the most important factor. The change commences in the muscular fibres of the tunica media, in which a deposit of lime salts occurs, so that the vessels become pipe-like and inelastic, and incapable of accommodating themselves to the requisite variations in the blood-supply. Hence a fixed minimal amount of blood passes into the limb, which is thus thrown into a chronic state of anæmia and malnutrition. The tunica intima, moreover, is often roughened so as to predispose to thrombosis with or without injury. The larger trunks may also be in a condition of atheroma. (*b*) A *weak heart* is generally present, leading to low pulse tension, and increased difficulty in propelling the blood through the narrowed vessels. (*c*) The *venous return* may also be *interfered with* by the existence of varicose veins, or an emphysematous condition of the lungs; whilst (*d*) the *condition of the blood* may be *impoverished* by albuminuria. When such predisposing factors are present, anything that results in (*e*) *thrombosis either in the main trunks or in the peripheral arterioles or capillaries* is likely to determine the onset of gangrene. Thrombosis of the main vessels may be due to some injury to the limb which is often overlooked, or more frequently arises idiopathically from a deposit of fibrin on the already roughened walls. If the obstruction originates in the smaller trunks or capillaries, it is almost always brought about by some slight injury, such as striking the ball of the great toe against the table, or even cutting a corn. Exposure to cold may also act as an exciting agent. In either case the clotting extends for some distance, and the height to which the gangrene spreads will vary accordingly.

Symptoms.—Preliminary evidences of malnutrition of the limb will probably have been noticed for some time in the form of cramp and pain in the muscles, which rapidly become fatigued and tired, whilst sensations of pins and needles or numbness are also complained of. The circulation in the tibials may be so slight as to be scarcely perceptible, and the whole limb feels cold and heavy. The skin is frequently more or less congested, and extremely prone to low forms of ulceration or eczema. When the gangrene commences as a result of some peripheral lesion, an area of painful redness is usually first noticed, perhaps running on to ulceration, and in the centre of this patch a slough is formed, which becomes dry and black. The process gradually spreads from this focus with more or less inflammation, so that it is sometimes known as 'inflammatory senile gangrene.' If, however, it is idiopathic in origin, and especially if the result of thrombosis of the main vessels, death occurs without the supervention of local inflammatory phenomena, the toes merely shrivelling up and dying, whilst there is marked pain along the limb ('non-inflammatory senile gangrene'). The inner side of the great toe is perhaps the commonest situation for the commencement of the mischief, and thence it spreads from one toe to another, and also along the instep and up the ankle to the leg. Pain is a most marked feature, whilst the extent of the gangrene is dependent partly on the amount of general and local vitality, and partly on the asepticity or not of the surrounding parts. As the disease spreads, the patient tends to become exhausted by the long-continued pain and want of sleep; and septic fever, bedsores, or the intervention of some pulmonary complication, may also hasten a fatal termination.

The **Treatment** adopted until within the last few years was governed by the observation that any attempt to remove the dead tissues by amputating in neighbouring living parts was doomed to failure, on account of a similar process starting in the flaps; if merely cutting a corn suffices to originate the malady, much more would so severe an injury as an amputation. The parts were dusted with iodoform, or some similar antiseptic, and wrapped in cotton-wool to keep them warm; the surgeon then waited for a line of separation, and even then did not amputate, but merely assisted Nature by dividing tendons or bones. At the same time, the general health was maintained by the judicious administration of suitable nourishment, stimulants and tonics, whilst pain was alleviated by the use of opium in such doses as the condition of the kidneys allowed. In spite of every care, however, the old and enfeebled constitution of the patients often proved unequal to the task of ridding the body of the dead mass, so that death from exhaustion or blood-poisoning was the rule rather than the exception, and even if the patient did recover, the prolonged and enforced stay in bed diminished his vital powers considerably.

It has now, however, been clearly demonstrated that *early amputation* performed under careful antisepsis, and *well away from* *the dead mass* at a point where the surgeon considers the blood-supply sufficient to nourish the flaps, and yet not so near the trunk as to seriously threaten life through shock, holds out the best prospects of relief. In order to determine the most favourable site for the amputation, the pulsation in the main artery should be felt for, and if feasible no operation performed at a spot where it seems to be occluded. The condition of the limb will largely influence the surgeon's decision ; if thin, attenuated, and shrivelled, with but little subcutaneous fat, it will be wise to amputate high ; but if the limb is fairly well nourished and with plenty of adipose tissue, the operation may be performed at a lower spot without danger. The colour of the skin, indicating the freedom or not of the cutaneous circulation, should be also observed. In operating, as little damage as possible should be inflicted on the parts, the flaps being nearly equal in length and not too flimsy, a circular amputation, or some slight modification of it, being perhaps the best. In many cases where the mischief is limited to the foot, it will probably be found necessary to amputate through the lower third of the thigh, or at any rate in the neighbourhood of the knee-joint.

II. **Traumatic Gangrene.**

By traumatic gangrene is meant the loss of vitality of some part of the body as the result of an injury, whether applied to the main bloodvessels (indirect traumatic gangrene), or directly to the tissues (direct traumatic gangrene).

(*a*) **Indirect Traumatic Gangrene** may arise from a considerable variety of lesions, and the resulting course and clinical history is similarly variable.

(i.) *Ligature of the main artery* should not produce gangrene in a healthy limb; but where it has fallen into a state of chronic malnutrition and anæmia from preceding arterial disease, death of a certain portion may result, the case running a similar course to one of gangrene due to embolus. It is usually of the dry type, one or two toes shrivelling up ; but if it reaches the more fleshy portions, it may remain moist.

Where the gangrene is limited in extent, **Treatment** consists in waiting for a definite line of separation to form, an antiseptic dressing being applied and the general health built up, and then in assisting the natural processes at this spot by dividing tendons and bones. Where, however, a considerable area of the limb loses its vitality, and especially if the dead tissue is moist and septic, an early high amputation is called for.

(ii.) *Arterial thrombosis from injury* will, similarly, only cause gangrene under special circumstances, the course and treatment being similar to that for the senile type.

(iii.) *Obstruction to both main artery and vein* is an almost certain precursor of gangrene. A few cases are, however, on record in which both vessels have been ligatured, or even portions of them removed without leading to gangrene, as in dealing with cancerous deposits in the axilla, or in the extirpation of aneurisms; but in both these instances there has been previously present such an obstruction to the circulation, as must have necessitated the opening up of collateral anastomotic branches. In a normal limb the occlusion of both afferent and efferent trunks is well-nigh sure to determine tissue necrosis. It may therefore be caused by the inclusion of both vessels in a ligature, or by the *strangulation* of organs, either within the body, as in a strangulated hernia, or outside of it, as when a ligature is tied round the base of the penis, or a bandage applied too tightly round a fractured limb. It may also occur under the latter circumstances from the limb becoming swollen from extravasation of blood or inflammatory exudations after the bandage has been put on with no undue tension.

A very similar result may be produced by the excessive hyperæmia and exudation following the sudden relief of a tightly-constricted part, which has thus been deprived of fresh arterial blood for some time; the vessel walls are thereby so damaged that they are unable to resist the blood-pressure, and hence the phenomena of inflammation are manifested to such a degree that the circulation is brought to an absolute standstill owing to the amount and pressure of the exudation. This occurrence is sometimes met with after frost-bites, and also in a loop of bowel, which has been strangulated, after removing the obstruction to the circulation.

A similar train of symptoms may result from rupture of the main artery, and compression of the vein by the extravasated blood, an occurrence perhaps most frequently seen after *fractures* and *dislocations;* it is always of the moist type.

As to **Treatment**, the parts are kept warm and rendered aseptic until such a time as gangrene is definitely established, and then amputation through the site of obstruction, or just above it, must be undertaken. It may be possible to save a limb when gangrene is threatening from fracture or dislocation by cutting down at once, turning out any clots which may have formed, and securing the divided or lacerated vessels, whilst at the same time the cause of obstruction in the shape of the displaced bone is dealt with by some suitable surgical measures.

(*b*) **Direct Traumatic Gangrene**, or that resulting from the immediate effect of injury to the parts, is similarly due to a variety of lesions.

(i.) *Severe crushes or blows* are a common cause of this type of gangrene; thus a limb may become mangled between the wheels of machinery, or by heavy weights falling on it, or by the passage of vehicles over it. Not only are the parts crushed, severely contused, or even 'pulped,' but the bloodvessels may be torn, and the resulting extravasation assists in determining the condition. The gangrene is of the moist type, and is more likely to supervene in patients whose circulation is defective, or whose vitality is diminished. Thus, a crush of the foot in an elderly patient is often liable to lead to it, whereas in a young and healthy adult it might be prevented.

Treatment.—If the part is hopelessly damaged, there is not the slightest use in retaining it in connection with the body, whilst the patient may run considerable risk from the onset of sepsis; and therefore immediate amputation should be undertaken. The question of shock and its influence in determining operation is discussed elsewhere (p. 206). Where there seems a reasonable chance of saving the limb, it is cleansed and purified under the strictest antiseptic precautions. Should gangrene supervene, it may be removed later.

(ii.) *Prolonged pressure* is also easily capable of producing gangrene, such as that which arises from injudicious splint pressure or in the form of bedsores. *Splint pressure* is a cause that should easily be eliminated if sufficient care is taken in adjusting and padding the splints prior to applying them, and hence only occurs as an accidental circumstance or from carelessness. Where there is a well-marked tendency to displacement of fragments after a fracture, it may be necessary to use some considerable degree of pressure to counteract it, and then in spite of every precaution necrosis of the superficial parts may ensue. Pain of a neuralgic type is usually complained of for a few days, but even that is not necessarily severe enough to attract much attention; when the limb is freed later on, the dead portion of the skin appears white, anæmic, and insensitive. A case of this type was noticed by one of us some years back, where the pressure needed to retain a foot in place after a subastragaloid displacement was sufficient to lead to gangrene, in spite of the patient not having complained of any great discomfort. The necrotic process may extend to some depth, and hence the greatest care must be taken to keep the dead tissues aseptic, as otherwise diffuse suppuration may spread along the muscular and fascial planes, and lead to considerable local and constitutional disturbance.

Bedsores are met with in patients who are kept for any length of time in the recumbent posture, or in any one particular position. The parts most exposed to pressure first become red and congested, and finally ulceration or actual gangrene supervenes. As a general rule, bedsores are not very extensive or deep, but occasionally when the patient is debilitated, and especially if a condition of lowered sensation is present due to impairment of the nerve-supply, as in paraplegia, the process may extend widely and deeply, destroying fasciæ, laying open muscular sheaths, and even leading to necrosis or caries of bones. The spinal canal itself has been opened in this way, and death from septic meningitis has resulted. To prevent the occurrence of such sores, the most scrupulous attention should be given to the parts exposed to pressure. The nurse must see that the draw-sheet or bed-linen is placed smoothly and without creases, and that no contamination by urine or fæces is allowed; if the patient is perspiring freely, the sheet should be frequently changed, so as to prevent decomposition of the sweat. The skin of the back should be daily examined, washed with some unirritating soap, and rubbed with a soothing, strengthening, and hardening application, such as spirit of wine, methylated spirit, or perhaps, better still, a mixture of brandy and white of egg. It is then dusted over with a mild antiseptic powder, such as boracic acid. If the skin becomes red, it should be painted with collodion, and protected from pressure by means of a circular hollow water-pillow. Paraplegic patients or old people should at once be placed on a water-bed, which must be sufficiently, but not excessively, distended. If there is too little water, the weight of the body displaces it to one side, and no good results; whilst if there is too much, the bed becomes hard and resistant, and fails in the object for which it was employed. When an open sore forms, it must be kept aseptic, and dressed either with boric acid ointment, or in the more sluggish cases with resin and boric acid ointments mixed. Friar's balsam is also useful in this condition.

(iii.) The action of *corrosive or caustic chemicals* is often followed by a localized traumatic gangrene, the degree of which will vary with the amount and character of the irritant present, and the duration of its action. All that is needed, as a rule, is to keep the parts aseptic, and allow them to be absorbed or separated by natural processes.

III. Specific or Infective Gangrene.

All the forms of gangrene included in this group are characterized by their origin in the development of micro-organisms, which by the virulence of their products determine the death of the affected tissues.

(*a*) **Acute Spreading or Spreading Traumatic Gangrene** (the **Gangrène foudroyant** of Maisonneuve).—This disease is one of the most rapidly fatal and serious met with in surgery.

Causes.—(i.) The *individual* attacked is as a rule predisposed to septic inflammatory conditions, as a result of vicious or careless living, or from simple malnutrition. Those who are in the habit of consuming large amounts of alcohol, even if not actual drunkards, such as brewers' draymen, who are continually soaked with drink, are especially liable to this affection. Some forms of virus, which are particularly active, may lead to a development of this disease even in a healthy person.

(ii.) The *lesion* from which it originates is usually a severe one, such as a compound fracture or dislocation, especially if the soft parts are much contused, or if dirt is ground into them. It also originates from small and insignificant pricks, scratches, or abrasions, if thereby a virulent organism gains access to the tissues. In this way post-mortem porters, nurses, or pathological demonstrators may become infected, and the gravest consequences ensue.

(iii.) As to the *organism* present, that most commonly met with is the *bacillus of malignant œdema*, first isolated by Koch (the *Bacillus septicus* of some authors). It is a rod-shaped microbe, somewhat longer and more slender than that of anthrax. It is anaerobic, and in its growth liquefies gelatine, and produces an unpleasant penetrating odour. On injection into the subcutaneous tissues of a mouse, the animal dies in eight to fifteen hours; locally a spreading œdema is produced, the connective-tissue spaces being filled with fluid containing bacilli, and perhaps some gas-bubbles. Bacilli are also found in the exudations which occur in the serous cavities, in the connective tissues of important organs, and in the blood for some time after death. Similar results are also said to occur from the activity of the *Bacillus aerogenes capsulatus*. There is some little doubt as to the exact *modus operandi* of the organisms, but it is probable that they originally develop in the damaged or dead tissues of the wound, and that the toxines thereby produced are absorbed along the lymphatics of the limb, giving rise to inflammation wherever they spread, and thereby producing a suitable soil in which the microbes can further develop.

The **Symptoms** are those of a hyperacute cellulitis, accompanied by those of general septicæmia. The wound early takes on an unhealthy action, the surface becoming covered with sloughs, and a thin serous or sero-sanguineous discharge being exuded. The inflammatory process rapidly spreads along the connective-tissue planes of the limb, which becomes swollen, painful, and brawny. At first it is of a dusky purplish colour, but soon evidences of actual gangrene supervene, and the necrotic tissues become crepitant and emphysematous, partly from simple putrefaction, partly from the gaseous developments associated with the growth of the specific organism. At the same time evidences of profound toxic disturbance manifest themselves, the patient perhaps having a high temperature and being delirious; but not uncommonly this may be entirely absent, the temperature being subnormal and coma present. The outlook is exceedingly grave, death usually ensuing in from five to seven days after the onset.

The only **Treatment** which holds out much hope in dealing with a limb where the disease is rapidly extending is a high amputation, even through the shoulder or hip-joint. Any delay is dangerous, although, in spite of the greatest promptitude, the infection may have progressed so rapidly that death follows from septicæmia even after the limb has been removed. In a few cases where the patient is seen early, it may be possible to save both life and limb by freely incising the affected tissues, and immersing them in a continuous warm, antiseptic bath. At the same time the general health must be attended to by giving plenty of fluid nourishment, together with diffusible stimulants, such as ether and ammonia, and possibly full doses of opium.

(*b*) **Hospital Gangrene and Wound Phagedena** are conditions affecting wounds which were seen often enough in the pre-antiseptic era, but are now practically unknown, thanks not only to antisepsis, but to the increased care directed to ventilation and hospital hygiene. They consisted in a rapidly spreading ulceration or gangrene, which attacked operation wounds a few days after their infliction, and as a rule led to rapid death. It is fortunately unnecessary nowadays to describe or discuss them.

(*c*) **Necrosis of Bone** is practically always due to the development of organisms, and may be either acute or chronic. In the former, the inflammatory reaction is so severe that the vessels become strangled within the bony alveoli; in the latter, it is largely due to an obliterative endarteritis, which accompanies the various specific processes. This subject is fully discussed in Chapter XVIII.

(*d*) **Cancrum Oris and Noma.**—**Cancrum oris** is an infective gangrenous stomatitis, affecting young children living in squalid surroundings in over-populated districts of large cities. The patients are always in a low state of health, and frequently convalescing from one of the exanthemata, particularly measles. The process starts in an abrasion of the mucous membrane, which, being infected often from a diseased or dirty tooth, becomes inflamed and gangrenous. A foul ashy-gray pultaceous slough forms on the inside of one of the cheeks, and from this the most offensive discharge is poured forth into the mouth and swallowed, the breath in consequence becoming intensely fœtid. The gangrenous process gradually spreads both superficially and deeply; the cheek becomes swollen, shiny, and tense, and, should the process extend through its whole substance, a black slough forms on its outer aspect, and gradually increases in size. In the worst cases, the adjacent bones of the face may be affected and die, and the tongue, palate, and even the fauces, may be also involved.

The general phenomena are those of a severe sapræmia, since not only are the toxic products swallowed, but they are also absorbed by the lymphatics, and may be inhaled, in the latter case giving rise to septic pneumonia. Moreover, the patient runs a considerable risk of developing pyæmia, from implication of the facial or other veins in the necrotic process, whilst infective septicæmia may also supervene. Rigors and high fever often occur early in the case, but death is usually preceded by symptoms of collapse and coma with a subnormal temperature.

The **Treatment** must be prompt and energetic if the child's life is to be saved. The patient should be at once anæsthetized, and all the pultaceous slough scraped from the interior of the mouth by means of a Volkmann's spoon, until healthy bleeding tissue is reached. The denuded surface is then freely rubbed over with pure carbolic or strong nitric acid. If the bones of the face are involved, they must be removed, as also any offending tooth. Afterwards the child should be well fed up, and preferably for a time with fluids; the mouth is to be frequently washed out with antiseptic lotions, such as a solution of sanitas (1 in 10), boroglyceride (1 in 20), or permanganate of potash, or with a gargle of chlorate of potash (10 grains to 1 ounce). A mixture containing chlorate of potash, dilute hydrochloric acid, and infusion of cinchona, may be administered for a few days, and then iron and quinine. In the most severe cases the same treatment should be adopted, even if the whole thickness of the cheek has been encroached on; loss of substance must be made good by subsequent plastic work. Necessarily, the cicatrization following this destructive process results in a good deal of permanent impairment to the movements of the jaw.

Noma is the name given to a similar process occurring about the genital organs of children, especially the vulva of young girls.

The **Treatment** to be adopted is identically the same, except that here it may be possible to immerse the patient in an antiseptic bath, thereby diluting the toxic products, and possibly preventing the necessity of having recourse to more serious surgical procedures.

(*c*) **Carbuncle and Boil.**—A **Carbuncle** is an infective gangrene of the subcutaneous tissues, due to a local invasion with pyogenic microbes, the commonest being the *Staphylococcus pyogenes aureus*. It occurs in individuals run down by any general debilitating condition, such as albuminuria or diabetes, and in whom the germicidal powers of the tissues are much depreciated; it is also met with occasionally as a sequela of acute fevers. The exciting cause may be some blow or squeeze, resulting in extravasation of blood, or some local diminution of vitality; into this area cocci are implanted either by auto-infection, or more usually through the sweat-glands or hair follicles, or through some slight superficial abrasion.

Signs.—A carbuncle commences as a hard painful infiltration of the subcutaneous tissues, the skin over which becomes red and dusky. The swelling gradually increases in size in all directions, until even a diameter of six or more inches is reached. As it extends peripherally, the central parts, which were formerly brawny, become soft and boggy, and the overlying skin shows evidences of yielding to the pressure within. Vesicles form on the surface, and finally pustules; these in turn burst, and allow a tardy exit to the ashy-gray sloughs and purulent discharge accumulated below. Fresh openings gradually form, leading to a cribriform condition of the cutis, due probably to the passage of the pus along the lines of least resistance, viz., the perforations of the cutis at the sites of the sebaceous glands and hair follicles. Some of these apertures enlarge and run into one another, producing a central irregular crateriform opening, at the bottom of which lies the necrotic tissue. As the violence of the inflammation subsides, the sloughs gradually separate, leaving a clean granulating wound. Carbuncles most frequently occur on the back, the nape of the neck, the shoulders, and nates, where the vitality of the tissues is never very active; when they form on more vascular parts, such as the face and lips, the consequences may be even more serious, owing to the onset of an infective thrombosis of the large veins which are here present. They are usually single, and may be accompanied by a painful enlargement of the nearest lymphatic glands.

There is usually considerable constitutional disturbance of an asthenic type, although the temperature is not necessarily much raised. Sometimes the gravest symptoms of blood-poisoning (pyæmia or septicæmia) may supervene.

Diagnosis—1. *From Boils.*—*Pathologically*, a boil is an infective gangrene of a small portion of the skin. A carbuncle affects the subcutaneous tissues primarily, and the skin only secondarily. *Clinically*, boils are multiple, conical in shape, more localized, and when suppuration has occurred the process is terminated by the discharge of the pus and slough through a single opening. Carbuncles, on the other hand, are usually single, much larger, flatter, and the sloughing process may continue peripherally, whilst the central part is discharging its sloughs through several openings. 2. *From Gummata.*—Cutaneous gummata are usually multiple, occurring in patients with a distinct and often recent syphilitic history. They are not very painful, and do not tend to attain any great size. They usually ulcerate early, leaving circular sores, or if multiple, sores with serpiginous outlines; there is usually but little definite sloughing. The deeper gummata are also less painful, have but one opening, and leave excavated sores, in the bases of which are yellowish sloughs like wet wash leather. The discharge is usually not distinctly purulent, but more like bloodstained gum.

The **Prognosis** of carbuncle mainly depends upon the condition of the internal organs. If the patient is a confirmed sufferer from diabetes or albuminuria, there is always considerable risk of his sinking from exhaustion. The vascularity of the parts also influences the result, as although there is more reparative power about a vascular region like the face, yet the implication of large veins may lead to embolic pyæmia.

Treatment must always be of a tonic, supporting character.

Good food, iron, quinine, and alcohol according to judgment, must be administered, whilst appropriate medicine (*e.g.*, codeia or opium) and limitation of diet are necessary in diabetic patients. Locally, many different forms of treatment have been suggested. The most thorough and satisfactory is to lay the carbuncle freely open under an anæsthetic, and scrape with a sharp spoon or cut away all sloughs until healthy tissue is reached, and then to thoroughly disinfect the cavity with pure carbolic acid. The hollow thus formed is stuffed with antiseptic dressings, such as gauze soaked in an iodoform emulsion (10 per cent.), and the case will then probably proceed rapidly to convalescence. Another less radical proceeding, especially suited to old people, is to make a free crucial incision, and allow the sloughs to separate, assisting matters by antiseptic poultices. The old plan of destroying the cutis with potassa fusa is extremely painful, and has nothing to recommend it.

In the early stages, it has been proposed to inject the surrounding tissues with pure carbolic acid in the hope of destroying the organisms, and thus preventing suppuration. In a certain number of cases this object will be successfully accomplished, but where the organisms are at all virulent, it will probably fail.

A **Boil** or **Furuncle** is a still more limited form of gangrene than a carbuncle, in that only a small portion of skin and subcutaneous tissue, usually round a hair follicle, is destroyed. Experimentally, a plentiful crop of boils can be produced by rubbing a culture of staphylococcus into the skin, and clinically it is supposed that a similar infection through the hair follicles is the most common cause of this condition. The secondary boils around a primary one are without doubt due to the friction of the dressings covered with pus and microbes upon the healthy integument.

People with a coarse skin and a tendency to comedones, or obstruction of the sebaceous follicles, are specially liable to the occurrence of boils. A gangrenous inflammation ensues after infection, resulting in the death of the hair follicle, or of the sweat or sebaceous gland involved, and of the surrounding connective tissue, and the slough thus formed is cast off by a process of suppuration. A matured or ripe boil, therefore, consists of a central slough or core, a zone of pus around it, and external to this granulation tissue merging into healthy skin and connective tissue. Although infection from without is the local exciting cause, there is frequently present some depression of the vital powers; such may lead to crops of boils recurring again and again.

Signs.—A boil commences as a small red irritable pimple, from which a hair may often be seen to protrude, which increases gradually in size, becoming more and more painful, until it forms a conical tumour, deep red in colour and exquisitely tender. A small whitish spot appears in the centre, and around this so-called core yellow pus can be seen. Finally it bursts, discharging the pus, and subsequently the core or slough comes away. The process is then at an end, and the wound rapidly heals by granulation. Occasionally the inflammation extends a little more deeply into the subcutaneous tissues, constituting a 'carbuncular boil.' The neighbouring lymphatic glands become sympathetically enlarged and painful, but rarely suppurate. A succession of boils may appear one after another in the same individual for weeks or months. Occasionally they subside without suppuration, leaving the parts thickened and infiltrated, a condition known as a 'blind boil.'

Treatment.—Locally, many boils may be left to burst naturally, though possibly the process may be checked by surrounding them with a piece of ordinary adhesive plaster, with a hole over the apex of the swelling. As a rule, however, one hastens matters by applying poultices, and incising when mature. Constitutionally, tonics are usually called for, except in plethoric individuals, in whom a spare diet and abstinence from stimulants may be recommended. A change of air to a bracing seaside place is often advisable, especially when the condition persists, crops of boils appearing from time to time. Sulphide of calcium ($\frac{1}{6}$ to $\frac{1}{4}$ grain) combined in pills with quinine and iron may also be administered, but the former drug is probably not of much value.

IV. Gangrene from Thermal Causes.

1. **Frost-bite.**—This condition is not very frequently seen in this country, but is by no means uncommon in regions where the winter is more severe. It occurs in those who are exposed to the cold, and the symptoms are induced more readily if a high wind is blowing, the heat of the body being thereby more quickly dispersed. It may originate in one of two ways:

(*a*) *From the direct effect of cold on the tissues*, which become shrunken, hard, and of a dull, waxy appearance. No pain is, as a rule, experienced in the freezing process, so that onlookers are more likely to recognise the condition than the individual himself. The extremities of the body, where the circulation is a little sluggish, and exposed parts, are chiefly liable to be attacked. and thus the nose, ears, fingers, and toes are most often involved. It is also more likely to occur in the young and in old people, whose vital powers are not very great. Gradually the part shrivels up, turns black, and is either absorbed or separated by a process of ulceration with or without suppuration. The most marked feature of gangrene from frost-bite is the more extensive implication of the superficial parts on account of their greater exposure.

(*b*) *From the subsequent inflammation* that arises in parts which, though frozen, are not immediately killed. The thawing of such structures is accompanied with the severest pain, and the prolonged anæmia causes such a lowering of the vitality of the vessel walls that the re-admission of the circulation is only too likely to be followed by an acute inflammation, which terminates in necrosis from strangulation of the vessels. If it escapes actual death, the part remains red, congested, and painful for some time, and superficial ulcers may even form; eventually, however, it recovers.

Treatment.—The frozen parts must be thawed very gradually, and the blood admitted into the tissues very slowly if inflammatory gangrene is to be avoided. They should be gently rubbed with snow or cold water, and gradually warmed by being held in the hands of the manipulator, and the patient should be placed in a cool room, the temperature of which is raised but slowly. As reaction comes on, a small amount of warm drink may be cautiously given. Excessive pain or congestive œdema may be limited by elevation of the part. If actual gangrene occurs, the dead tissue must be rendered and kept aseptic, and the case carefully watched until a definite line of separation has formed.

2. **Burns and Scalds.**—These may be considered as a special variety of wound, not necessarily ending in gangrene, brought about by the action of heat; burns, either by the close proximity to, or direct contact with, flame or heated solid bodies; scalds, by the action of boiling water, superheated steam, or other hot fluids or gases, the difference in the effects being comparable to the distinction between roasting and boiling. Naturally fluids, such as oil, which boil at a higher temperature than water, produce increasingly severe results.

The **Effects** of burns and scalds vary with the source of heat, its intensity, and the duration of its application. Six different degrees of burn were described by Dupuytren, and his classification may still be retained with advantage. The *first degree* consists merely in a scorch or superficial congestion of the skin, without destruction of tissue. The part may, however, remain red, painful, and prone to ulceration for a time. Should the scorch be often repeated, as by people constantly warming their legs before the fire, the skin becomes chronically pigmented and indurated (*erythema ab igne*). In the *second degree* the cuticle is raised from the cutis, and a bleb or blister results. When this bursts, and the cuticle is removed, the cutis vera, red and painful, is exposed below. In the *third degree* the cuticle is destroyed, as is also part of the cutis vera, but the tips of the interpapillary processes, including the exquisitely sensitive nerve terminals, are laid bare and left intact: consequently this is a most painful form of burn. The deeper structures of the skin—viz., the sweat and sebaceous glands and hair follicles—remain untouched, so that, although the surface during the healing process becomes covered with granulations, the integument is very rapidly replaced, since there are so many epithelial elements from which it may grow. The cuticle is able to form not from the edge only, as must occur wherever the whole of the cutaneous envelope is destroyed, but also from innumerable foci scattered over the wound surface. The resulting scar is scarcely visible, and undergoes no contraction; it is supple and elastic from containing all the elements of the true skin. In the *fourth degree* the whole thickness of the integument is destroyed, as well as part of the subcutaneous tissues. In the *fifth*, the muscles are also encroached upon, whilst in the *sixth* the whole limb is charred and disorganized. In the last three forms healing can only occur by removal of sloughs and the formation of a cicatrix, which by its contraction may lead to subsequent deformity.

The **Local History** of a burn may be described in three stages, corresponding to the three stages through which an ulcer or a lacerated wound passes: (1) The stage of destruction or burning, the various degrees of which have been just alluded to; (2) the stage of inflammation and sloughing, whereby the dead tissue is removed, and the wound converted into a healthy granulating sore; (3) the stage of repair, which follows the course described elsewhere (p. 194). There are no special characteristics of these processes which call for particular note.

The **General or Constitutional Conditions** which correspond to these three stages require a little fuller notice.

1. As an immediate result of the burning and destruction of tissue, the patient lies for a time (greater or less according to circumstances) in a state of **shock**. It is important to recognise that the intensity of this depends not so much on the depth of the burn as on its extent, so that total charring of a limb will probably cause less depression of the system than an extensive superficial scorch, especially if the latter involves the abdomen. During this stage the internal viscera, especially those connected with the portal system, become intensely congested.

2. Whilst the separation of the sloughs is being effected, a period of **inflammatory fever** follows, due either to septic contamination of the sloughs, or to the absorption of the products of the charred tissues. It is usually of an asthenic type, and the patient is likely to be worn out unless he is carefully looked after. Any and every form of internal complication may arise during this stage, which usually lasts from four to fourteen days. Congestion of the brain or lungs is not uncommonly seen, but the gastro-intestinal tract is that, perhaps, most generally and seriously affected. The mucous membrane of the stomach and intestines becomes engorged with blood, leading to exhausting vomiting and diarrhœa, and possibly ulceration, or even peritonitis, may supervene.

During the later days of this stage, the curious sequela known as **Perforating Ulcer of the Duodenum** is liable to occur, although it is admittedly not at all common. The presence of an ulcer in the duodenum is suggested by pain in the epigastrium after food, perhaps some vomiting, which may be blood-stained, and possibly the passage of a motion containing a good deal of altered blood; but occasionally the first sign of such mischief is the sudden collapse of the patient, followed by rapid death, with or without peritonitis, owing to perforation or excessive hæmorrhage. The bleeding usually arises from erosion of the superior pancreatico-duodenal artery. If perforation involves the anterior wall, general peritonitis is certain to follow; but when the posterior wall is affected, a retro-peritoneal abscess may ensue, as also occurs in gastric ulcer (Chapter XXX.). The *Ætiology* of this condition is extremely obscure. The ulcers usually occur in the first or second part of the duodenum, and never below the entrance of the common bile-duct, although they may be found opposite its exit. In appearance they present a cleanly-punched-out loss of substance with little or no surrounding inflammation, and their distinct limitation suggests that they are due to the auto-digestion of a distinct arterial area, the vitality of which has been diminished by a preceding thrombosis of the vessel. This may arise from the lodgment of a capillary embolus, although why such should be located in this particular region is difficult to see. Another theory supposes that some irritative substance derived from septic or other changes in the burnt tissues is excreted by the liver, and that this is capable of inducing thrombosis in the tissues in close contiguity to the entrance of the bile-duct, or at any rate of producing ulceration. In proof of this idea, Dr. Hunter's experiments might be quoted, in which he succeeded in producing ulcers of the duodenum in animals by injecting toluymenediamin, as also the fact that this complication has become much less common since the introduction of antiseptics. That the condition is not necessarily fatal is shown by cicatrices having been found in this locality after death, when due to other causes.

3. When healthy repair is occurring locally, and the parts are kept aseptic, no abnormal constitutional condition should be present, although there may be a certain amount of **asthenia** or anæmia. Where, however, the parts are septic and suppurating freely, this tendency will be much more marked, and the patient may even die of exhaustion, combined with hectic fever and amyloid changes in the viscera.

Causes of Death from Burns.—If an individual is burnt to death, the fatal event is usually occasioned by asphyxia from the smoke and noxious fumes of the fire; shock and syncope from fright may perhaps be adjuvants, especially if the heart is weak or diseased. Within the first few days death results from shock or collapse; in the second stage, from sepsis, internal complications, ulceration of the duodenum, etc.; in the third stage, from exhaustion or intercurrent maladies. The prognosis in children is always more unfavourable than in adults.

Treatment.—It is impossible to do more here than sketch out some of the more important principles and plans that have been advocated.

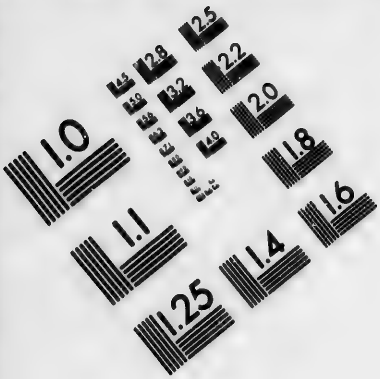
In the superficial scorches without vesication, all that is called for as a rule is the protection of the affected parts either by dusting them over with flour or painting them with collodion. Where blisters have formed, the cuticle should be washed antiseptically and then punctured, so as to allow the contained serum to escape, and then the area should be dusted with boric acid powder, and covered with salicylic wool. Carron-oil (*i.e.*, a mixture of equal parts of linseed-oil and lime-water) is also much used, applied on lint; it is, however, not an antiseptic, although by adding a small proportion of eucalyptus oil (1 to 10) this can be corrected. Latterly some French authorities have commended the use of picric acid as a dressing in cases of burns where the cutis vera has not been entirely destroyed; the vesicles are punctured, and then a piece of lint, soaked in a saturated solution of picric acid, is applied to the burnt surface, and over this, in turn, a pad of salicylic or sterilized wool is firmly bandaged. Thus a dry dressing is produced, which may be left *in situ* for some days, when it is reapplied. We have used this proceeding in several cases, and have been exceedingly pleased with the results.

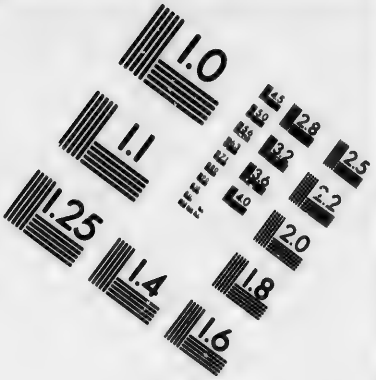
Where the burn includes deeper structures, the clothes must be removed with as little dragging as possible, being cut away if necessary; the damaged tissues are then well bathed with some antiseptic, such as carbolic lotion (1 in 40), and covered up as rapidly as possible with lint soaked in eucalyptus oil or weak carbolic oil. In some cases, where the skin and surface are exceedingly dirty, it is well to anæsthetize the patient, and then to cut away parts which must obviously slough and thoroughly purify the wound, which is then covered with protective, and dressed with cyanide gauze, or some such material.

At the same time, the general condition of the patient must not be overlooked; he is possibly in a state of considerable shock, and therefore should be put to bed and covered with warm blankets or rugs, whilst perhaps a little warm stimulating fluid is administered. In the case of children with very extensive burns, it is sometimes useful to put them into a hot bath, to which some eucalyptus oil, if obtainable, has been added; the clothes are then removed or cut away, and the patient allowed to remain for some time, or until the shock has subsided, in the warm water, which may, if necessary, be replenished. The wounds are then dressed, and the little patient removed to bed. It may be desirable to repeat the immersion at every dressing.

When a limb has been hopelessly charred or burnt to the bone, it is useless to retain it, and immediate amputation through the nearest healthy tissues should be undertaken.

When the next stage, viz., that of inflammation and sloughing,





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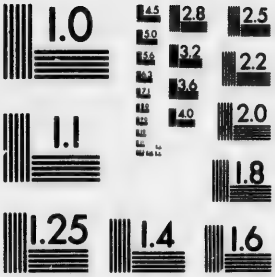

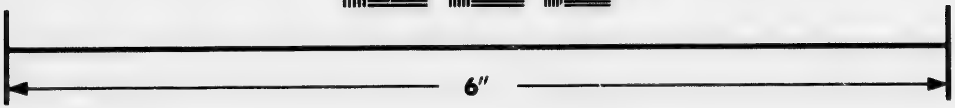

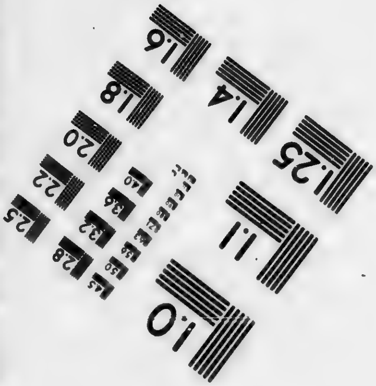

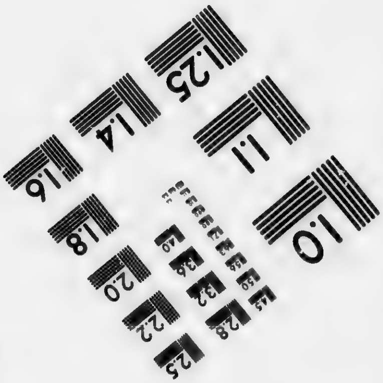

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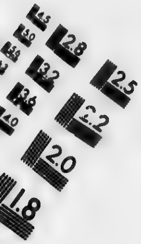

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has been reached, the only requisite is to keep the parts as aseptic as possible, assisting the natural processes of repair by warm moist applications, and snipping away sloughs as they loosen. Generally, attention to the ordinary rules of personal hygiene, and a simple diet, are all the precautions that need be taken.

When the stage of cicatrisation is reached, the granulating wounds are treated on general principles. The granulations often tend to become prominent, and stimulating applications, such as touching them with lunar caustic, may be called for. In large wounds, healing should be assisted by skin-grafting, according to Thiersch's method; unless some such proceeding is instituted, the wound is likely to become chronic, and healing may be delayed perhaps indefinitely. Sores involving the whole circumference of the limb are especially difficult to deal with; in one such case we were only able to bring about a cure by removing an inch or two from the humerus, and thus shortening the limb, according to the plan recommended by Professor Annandale.

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CHAPTER V.

SEPSIS AND INFECTION.

Sepsis.

A **Septic Process** is one due to the activity of organisms which have only the power of developing in dead tissues or fluids, or in passive material such as blood-clot, pus, or serum. They may occasionally gain an entrance into the general circulation, but are quickly disposed of, and do no harm. They are termed non-pathogenic or saprophytic microbes, and the processes resulting from their activity are akin either to putrefaction or fermentation. There are many bacteria in existence which can produce such results, and amongst them may be mentioned the *Proteus vulgaris*, *Micrococcus prodigiosus*, various forms of *sarcinæ*, *Bacillus subtilis*, *B. acidi lactici*, and, under certain circumstances, the *B. coli communis*. The action of these organisms is to reduce the more complex to simple compounds, thus bringing about their disintegration. At the same time, irritating or poisonous chemical products are formed, known as ptomaines, upon the action of which the symptoms of septic poisoning, whether local or general, are dependent.

Local Septic Processes are those produced in a wound or its immediate neighbourhood, or in a suitable cavity, by putrefactive changes arising in some substance within it. The ptomaines thus formed give rise to local inflammation, perhaps running on to suppuration, whilst their absorption along the lymphatics may cause a wide extension of the mischief. Amongst such conditions the following may be noted:

Wound Inflammation, arising either from septic contamination due to a dirty state of the skin, instruments or hands of the surgeon, or from a faulty dressing. In such cases the infective pyogenic organisms are usually present, as well as those which give rise to sepsis. It must be clearly understood that in clinical work the term 'sepsis' is often made use of, without any strict pathological significance, to indicate that the process of healing is not following a normal course, owing to the presence of micro-organisms. Many so-called septic wounds are in reality infected with some one pathogenic organism, whilst in almost every instance ordinary pyogenic (*i.e.*, infective) organisms are present, as well as those characteristic of sepsis. A dry wound is much less likely to become septic than one in which there is much exudation of blood or serum, so that absolute hæmostasis and good drainage are two most important preventive measures. When sepsis occurs, the lips of the wound become puffy, red, and swollen, and if there is much tension, the pain becomes very severe and throbbing. Healing comes to an end, and unless all tension is quickly relieved, not only will there be high fever, but the inflammatory mischief may also extend in all directions, leading to diffuse suppuration. All stitches should be immediately removed, the wound well washed out with some antiseptic, and stuffed with gauze soaked in an emulsion of iodoform and glycerine. Occasionally it may be advisable to temporarily apply an antiseptic fomentation. At the same time, the bowels are well opened, and the general health of the patient carefully attended to.

The **Persistence of Suppuration from a Chronic Abscess** is also due to sepsis. If it is efficiently excluded, the discharge consists of nothing but serum after the cavity has been once completely emptied; should sepsis be admitted, suppuration follows, accompanied by hectic fever.

The putrefaction associated with **Moist Gangrene** is also septic in origin, and from such a source, as also from dirty ulcers, neglected abrasions, and wounds, etc., various forms of diffuse or localized **Lymphangitis** may occur, with or without glandular enlargement.

The offensive odour associated with neglected syphilitic and cancerous ulcerations is again the result of sepsis, and no essential part of the causative affection. In either case, if the ulcerated surface is dealt with antiseptically, there is but little discharge, and no smell; but let putrefaction once occur, and the sore becomes intolerably offensive, whilst the local disease tends to spread more rapidly. Thus, in syphilitic affections of bones, necrosis is almost unknown apart from this complication.

Serous cavities may similarly become the seats of acute septic inflammations from punctured wounds, accompanied with effusion —*e.g.*, septic arthritis, septic peritonitis, etc.

The **General Septic Processes**, due to the absorption of ptomaines, may be described under three headings, viz.:

1. **Hectic Fever** (p. 45), in which a minimal dose is absorbed, spread over a long period of time.

2. **Septic Traumatic Fever**, due to the absorption of a somewhat larger amount of the poison after an operation or injury, which is followed by septic inflammation. A burn or compound fracture which is not rendered aseptic is always accompanied by fever, ranging from 102° to 104° F., for some days, until the wound is securely sealed off by the development of granulation tissue.

When once this has occurred, the fever usually disappears, as the absence of lymphatics prevents absorption, unless septic material is retained under pressure.

3. **Acute Sapræmia, or Septic Intoxication**, due to the absorption of a large dose of ptomaines. This condition was for long confounded with true infective septicæmia, and even now, though clearly distinguished pathologically, the distinction between the two clinically is not always possible, except by awaiting the result. Sapræmia is essentially a toxæmia, or condition due to chemical poisoning; the blood is not infective—*i.e.*, if a small quantity is inoculated into another individual, the disease is not reproduced, or, to put it in another way, the symptoms are directly proportionate to the dose. Any condition in which there is a large mass of putrefying tissue or fluid from which absorption can occur may lead to sapræmia—*e.g.*, a portion of decomposing placenta in the puerperal uterus, the existence of septic pus under pressure in the peritoneal cavity, a joint, or elsewhere; or a mass of putrefying blood-clot, say, in the pleural cavity after a penetrating wound.

The **Symptoms** usually commence, two or three days after the cause has come into operation, with a severe rigor, followed by a maintained high temperature, although sometimes it is subnormal in the more serious cases. There is loss of appetite, a dry tongue, a quick pulse rapidly becoming weak, severe headache, and nocturnal delirium of some intensity. The patient is at first constipated, but vomiting and diarrhœa may ensue from gastro-intestinal irritation, followed by fatal exhaustion and collapse; or the patient may become comatose and unconscious for some time before death, according to whether the ptomaines act chiefly upon the alimentary system or upon the cerebral centres. There is usually some dyspnœa from pulmonary congestion, and albuminuria. Should, however, the putrefying mass be removed tolerably early, the fever will cease as by magic, the tongue cleans, the appetite returns, the headache vanishes, and in twenty-four hours the patient feels a different individual.

Post-mortem Appearances.—Decomposition is early, rigor mortis feeble, and cadaveric lividity well marked, especially along the lines of the superficial veins and posteriorly. The blood coagulates imperfectly, and is dark and tarry in colour; if allowed to stand, the serum which separates from the corpuscles is much stained from the breaking-up of the red blood-cells which occurs in all septic and infective cases. This condition explains the amount of cadaveric lividity, and also the post-mortem staining of the endocardium and tunica intima of the larger vessels, which is such a marked feature in these cases, and which was formerly thought to result from a diffuse arteritis. Most of the serous cavities contain a certain amount of blood-stained serum, and under almost all the serous membranes are well-marked petechiæ, especially under the pericardium and pleura. The lungs are deeply congested, especially at the back, and very œdematous; the liver, spleen and kidneys are enlarged, pulpy, soft and congested, but particularly the spleen. The epithelium of most of the secreting glands, if examined microscopically, gives evidence of cloudy swelling.

The **Treatment** of acute sapræmia must be almost entirely directed to the local cause. If it arises from a wound, such as a compound fracture, the latter must be freely laid open, washed out with antiseptics, and drained; if from a cavity containing putrid blood, serum, or pus, the fluid must be immediately evacuated, the cavity well flushed out, and efficient drainage provided; possibly continuous irrigation may be advisable. If a sloughing wound is the cause of the mischief, the sloughs must be cut or scraped away under an anæsthetic, and the surface disinfected with chloride of zinc or pure carbolic acid. A putrid gangrenous limb demands amputation.

General treatment is merely symptomatic. Possibly a good purge may be advisable in the early stages, but in the later a supporting and stimulating plan of treatment must be adopted. Recently it has been proposed to deal with the acute toxæmia of peritonitis and similar conditions by the repeated injection into the veins of large quantities of normal saline solution, and a number of excellent results have been obtained by this means, the injections being followed by diuresis and diarrhœa, which presumably assist in the elimination of the virus. (See also on Septicæmia, p. 106.)

Infection.

An infective process is one due to the activity of microorganisms which can develop in living tissues—the true pathogenic bacteria or parasites. Such find an entrance into the body in many ways, as through the healthy skin, or by the mucous membranes of the alimentary canal, respiratory tract, or genito-urinary apparatus, or through wounds and abrasions; and very often the manifestations of disease differ widely with the channel of entrance. These may also be divided into two main groups: the Local and the General.

Local Infective Processes are those caused at the spot of inoculation by the growth and development of the microbes. After a period of incubation—which varies with different organisms, and during which we may imagine that they are struggling with the germicidal action of the tissues, and establishing their foothold in the body—the organisms begin to grow and multiply, and by the deleterious products of their activity cause irritation of the tissues and various forms of inflammation.

These inflammatory foci may remain limited, or may tend to spread with more or less rapidity by continuity of tissue or along lymph channels; or the organisms may be widely disseminated through the body by the bloodvessels in the shape of emboli. A certain amount of constitutional disturbance may accompany these manifestations due to the absorption of the toxines produced locally, whilst in some diseases the general toxic symptoms (or toxæmia) associated with some slight local mischief may be extremely severe, as in tetanus and diphtheria. Hence local infective processes may be classified in two divisions: (*a*) those in which there is no general toxæmia, such as a soft chancre, a tubercular abscess, or an ordinary attack of gonorrhœa; and (*b*) those in which the toxæmic condition is well marked, as in erysipelas, tetanus, diphtheria, etc., the character of the symptoms varying necessarily with the different toxines.

Many of the organisms which are the causes of local infection may also develop generally in the system, and produce grave constitutional affections.

General Infective Processes are those in which the organisms develop and multiply in the blood-stream, so that inoculation of a sound person with the blood would almost certainly transmit the disease. Many of the bacteria producing local infection may also give rise to these general diseases, and, indeed, in surgery we rarely see the latter without some local cause being present to explain its origin. Septicæmia, pyæmia, acute tuberculosis, the second stage of syphilis, anthracæmia, and probably the exanthemata, are illustrations of general infection.

We now propose to pass in review the chief forms of infective disease met with in surgical practice. Acute suppuration has already been dealt with (Chapter II.); it remains to discuss the various forms of cellulitis, erysipelas, septicæmia, pyæmia, tetanus, hydrophobia, and anthrax, and subsequently to deal with those grouped together under the term 'infective granulomata.'

Cellulitis.

Cellulitis (or, as it used to be termed, *diffuse phlegmon*) is a disease which, although exhibiting many diverse manifestations, is characterized by the great general feature, viz., the existence of a spreading inflammation of the subcutaneous or cellular tissues, due to the activity of micro-organisms, and running on to suppuration, sloughing, or even general gangrene.

As to **Causation**, the one essential, as we have just stated, is the infection of the cellular tissues with some organism capable of multiplying locally, and of developing toxic compounds, which not only act at the site of inoculation, but also extend along the lymphatics, and by their absorption into the general circulation, give rise to severe toxæmic phenomena. The entrance of the organisms may result from an operation wound which has been allowed to go septic, or from an accidental breach of surface which has not been rendered aseptic, or even from the slightest form of graze, prick, or scratch. Deep septic wounds which are not properly drained are amongst the most favourable for the development of this condition, especially if the general health of the individual is bad, or the hygienic surroundings are of an insanitary nature. In the deeper regions of the body, where much loose cellular tissue is present, inflammatory phenomena readily supervene from the absorption of septic material from neighbouring contaminated structures, *e.g.*, pelvic cellulitis arising from a septic uterus.

Cellulitis may arise from a considerable variety of *micro-organisms.* The less severe types are probably due to the *Staphylococcus pyogenes aureus* or *albus*, whilst the more severe are caused by the *Streptococcus pyogenes*, which, as will be stated hereafter, is probably identical with the organism of erysipelas. In many cases various types of non-pathogenic or septic organisms may accompany the above. The most acute forms of the disease running on to spreading gangrene are probably always the result of infection with the *Bacillus of malignant œdema* (p. 78).

Clinical History.—The symptoms manifested in any particular case must necessarily differ somewhat according to the site of inoculation and the virulence of the causative microbes, and hence anything from a merely localized suppuration to the acutest form of spreading gangrene may result. Taking a case of moderate severity, due to a prick or abrasion which has become infected, one finds that there is often a period of quiescence for a day or two, during which the virus is incubating and the original site of inoculation shows but slight signs of inflammation, beyond being a little tender. The patient, though feeling somewhat seedy, is able to continue his work, but finally is obliged to give up, owing partly to the increased pain, partly to his general condition. Fever will almost always be present to a greater or less degree, and in the more severe types one or more rigors may occur. Occasionally, however, the temperature may be subnormal, owing to the depressing effects of the toxic substances absorbed. On examining the affected part, it is found to be hot, tender, and infiltrated; if superficial, it looks red and angry, and may feel brawny. The course of the case depends to a very large extent upon the treatment adopted; if freely incised, the process becomes limited, and although suppuration may occur, there is but little sloughing, and hence repair is readily effected. If, however, it is left, or is merely poulticed, the process rapidly spreads, and may involve more or less the whole limb, which becomes greatly swollen, very œdematous, red, and brawny. Intense pain and sleeplessness, accompanied perhaps with delirium, form the most prominent symptoms, and this, accompanied by the toxic fever, rapidly exhausts the patient's strength. Finally, suppuration occurs beneath the skin, whilst the cellular tissue sloughs, perhaps the whole of the subcutaneous areolar tissue being thereby destroyed, although the skin only gives way in places. Hence it is often possible to pass a probe between the skin and the deep fascia over a considerable area. Sometimes the inflammation skips a part of the limb, and the chief focus of mischief is found at a distance from the original site of inoculation, the intervening portion being but little affected; such an occurrence is probably due to lymphatic absorption. Occasionally the trouble spreads along the deeper areolar planes, involving muscular bellies, which may be infiltrated with pus, or may actually slough. This occurrence is specially likely to occur when the disease is due to septic inflammation of a deep penetrating wound, such as follows a gunshot injury, or when the patient is very debilitated, as in acute spreading gangrene. In all these more severe forms the patient runs a considerable risk of developing general septicæmia, or even pyæmia.

Treatment.—With the exception of those rare cases due to the bacillus of malignant œdema, cellulitis results from the activity of organisms, which are readily destroyed, and over which the germicidal properties of the body have considerable control. Hence careful attention to the dicta of antiseptic surgery can prevent its occurrence to a very large extent. Abrasions and small punctured wounds should always be carefully protected, and all penetrating injuries disinfected, especially if the patient runs any risk of infection owing to his occupation or surroundings. Should inflammatory phenomena supervene, the application of antiseptic fomentations, such as the boracic poultice, may prevent their extension, whilst the bowels should be freely acted upon and the general health attended to. Failing this, and if there is any tendency for the inflammation to spread, incisions should be made into the brawny tissues, so as to give exit to the serous and irritating discharges; the wounds thus made are dusted with iodoform and stuffed with gauze, over which the usual dressings are applied; and it is often wise to incorporate a piece of mackintosh in the outer folds of the dressing, so as to keep the parts moist and encourage a free discharge. Under such a regime sloughing may be entirely prevented, or, at any rate, limited. At the same time the patient's health and strength must be maintained by the administration of suitable food and stimulants, whilst quinine is very useful internally.

Antistreptococcic serum has also been employed as a curative agent, and the results hitherto obtained have been encouraging. The dose varies from 5 to 10 c.c. two or three times a day. Another excellent plan of treatment is to immerse the wounds, after freely incising the infiltrated part, in a continuous warm bath, by this means diluting the toxines to such an extent as to render them innocuous. Warm water does perfectly well, although it may be boiled before use with advantage. Antiseptics are practically useless in checking the disease when once started; the surgeon has to depend mainly on the relief of tension, the removal of toxic discharges, and the antiseptic power of the tissues.

Special Varieties of Cellulitis.

Cellulitis of the Axilla is an exceedingly serious disease, not unfrequently resulting from an infected wound of the fingers, such as occurs in the post-mortem room, and hence is not uncommon in medical practitioners, students or nurses. It may also be caused by extension from a primary axillary lymphadenitis. The tissues of the armpit become hard and brawny, the pain is severe, and the disease is liable to spread towards the chest walls under or between the pectoral muscles; it may also travel upwards, and lay open the shoulder joint from sloughing of the capsule, and so give rise to an acute arthritis. The most extensive incisions are called for in order to prevent any risk of such complications, but respect must be paid to the important vessels and nerves contained in the cavity.

Submammary Cellulitis usually occurs as a result of the extension of inflammation from the deeper parts of the breast, or perhaps from the cartilages or bones of the chest wall. The areolar tissue beneath the breast becomes infiltrated and brawny, and the gland itself is somewhat swollen and tender. Should suppuration occur, the mamma appears to float on a fluid base. (See Submammary Abscess.) Free incisions must be made into the infected area along the lower portion of the circumference of the organ.

Cellulitis of the Scalp usually results from a wound which has traversed the occipito-frontalis aponeurosis, and opened up the subjacent layer of loose areolar tissue. Suppuration extends in all directions to the limits of attachment of this structure, and hence abscesses are likely to point in the forehead just above the eyebrows, or over the zygoma, or along the superior curved line of the occipital bone; whilst, in addition to the severe local and general disturbance, the patient runs a risk of necrosis of the skull and of various intracranial complications. For further details, see Chapter XXI.

Cellulitis of the Orbit is not an uncommon sequela of penetrating wounds in this region, owing to the difficulty of rendering them aseptic and of draining them. The whole of the orbital tissues are infiltrated and swollen, the lids become œdematous, and the eyeball is thrust forwards by the tension in the parts behind. There is a considerable likelihood of the inflammation spreading backwards to the meninges, owing to the fact that the dura mater is continuous with the orbital periosteum through the foramina by which the nerves and vessels enter. Necrosis of the orbital walls may also occur, whilst the eye itself may suffer either from an infective panophthalmitis due to lymphatic infection, or from optic neuritis secondary to retro-ocular inflammation and pressure, or at a later date from optic nerve atrophy secondary to cicatricial contraction around the nerve. If the cellular tissue of the orbit sloughs, the subsequent movements of the globe may be much hampered, or indeed lost, whilst the lids may be drawn back to such an extent as to prevent their complete closure. *Treatment.*—No penetrating wound of the orbit ought to be closed if there is any question of septic infection; indeed, it is often wise to slightly increase its size, so as to enable the deeper parts to be cleansed. Drainage must always be provided for, and in many cases this is best accomplished by stuffing it with gauze. If cellulitis follows, the original wound must be well opened up, and possibly fresh incisions may be called for either through the lids or through the fornix conjunctivæ. Antiseptic fomentations or poultices are then applied. If panophthalmitis supervenes, the best plan is to incise the eyeball crucially, and clear out its contents, rather than to entirely remove the globe.

Submaxillary Cellulitis, or, as it is sometimes termed, Ludwig's Angina, from the name of the surgeon who first prominently called attention to it, is an infective inflammation of the cellular tissue beneath the deep cervical fascia which occurs in elderly and weakly individuals or in children, without, as a rule, any apparent reason, although most probably it spreads from some buccal condition. It also occasionally results from inflammation extending beyond the capsule of inflamed glands, and may originate in disease of the middle ear, the mischief travelling downwards along the digastric muscle. It commences as a brawny induration in the submaxillary region, which is tender, painful, and hot; there is a certain amount of fever, and this increases *pari passu* with the extent of the area inflamed; it tends to spread to the front of the neck and base of the tongue, which may thereby be made to protrude from the mouth. Dangerous symptoms arise either from pressure on important vessels and nerves, from extension of the inflammation to the glottis causing œdema and consequent dyspnœa, or from the supervention of pyæmia owing to venous thrombosis. The process usually ends in sloughing of the cellular tissue and suppuration, the pus burrowing in all directions if a free exit by incisions through the deep fascia is not provided; occasionally a large sublingual abscess may form, causing the gravest constitutional and respiratory disturbance, whilst in rare instances the mass may remain stationary and indurated for a considerable time.

The *Treatment* must be prompt and energetic; a free incision is made along the median line into the midst of the brawny tissue, or along any line of safety where pus is threatening to form. A sublingual abscess may be opened from the mouth; but it is better, if possible, to do so from below, so as to exclude sepsis. Prior to suppuration, fomentations may be used; whilst tonics, stimulants, quinine, and plenty of good food are needed constitutionally.

Pelvic Cellulitis arises from extension of inflammation from the pelvic viscera to the loose cellular tissue ensheathing them. It may be due to lymphatic absorption from septic material contained in the uterus, or it may spread as a simple or septic inflammation from the ovary, Fallopian tube, or prostate. Injuries to the bladder or rectum may also light up the trouble. It is associated with all the local and general signs of deep inflammation, and often, indeed, with peritonitis, being evidenced by a tense, firm, painful swelling to be felt *per vaginam*, or *per rectum*, and often by an indurated mass of inflammatory effusion, dull on percussion, rising above the pubic arch. Abscesses may form in this effusion, bursting either externally or into some of the viscera, or possibly in both directions, producing very intractable forms of urinary or fæcal fistulæ, whilst venous obstruction and pyæmia are very likely to develop.

The surgeon may be called to deal with such cases either in the early presuppurative stage, when rest, limitation of diet, small doses of opium, and hot fomentations to the hypogastrium, conjoined perhaps with hot antiseptic vaginal or rectal douches, should be adopted; or later, when pus has formed and the abscesses need to be opened. No absolute directions can be laid down to meet every contingency, but, as a general rule, an incision is made just above Poupart's ligament and close to the pubic spine; the abdominal muscles are divided to a sufficient extent to enable the surgeon to work downwards between the transversalis fascia and the peritoneum. Occasionally it will be necessary to push the peritoneum well aside so as to reach the broad ligament, where pus is frequently met with. As soon as the subperitoneal tissue is opened, the knife should be discarded, and only blunt instruments or the fingers employed. The pus is often very offensive, owing to the presence of the *Bac. coli communis*; the cavity of the abscess should be well washed out and efficiently drained.

Intestinal obstruction may be met with as a remote sequela from the contraction of cicatrices forming subsequently to the cellulitis, and hydronephrosis may arise in the same way from pressure on the ureter.

Erysipelas.

Erysipelas is a specific infectious disease due to the development of the *Streptococcus erysipelatis* (Fehleisen) in the smaller lymphatics of the skin and subcutaneous tissues (and occasionally also of the mucous membranes), so that it may be defined as a spreading, infective, and contagious inflammation of the skin and mucous membranes, the constitutional symptoms being due to the absorption of toxines developed locally.

There has been considerable discussion as to whether there is any difference between the erysipelas microbe and the ordinary *Streptococcus pyogenes*, occurring in spreading suppuration. The microscopical characters are indistinguishable, and the growth in various reagents is very similar. Inoculation experiments, moreover, certainly seem to indicate that they are closely allied species, and the majority of bacteriologists consider them to be identical, the differing effects depending merely on the method of inoculation and the virulence of the particular organism; in accordance with this idea both react in marked fashion to the injection of an antistreptococcic serum, produced by utilizing the ordinary laboratory *Streptococcus pyogenes*. The chief objection to this theory is the great difference which exists between the 'infectiousness' of erysipelas and cellulitis. No surgeon would object to the presence of cases of the latter in his wards; none permit the presence of the former, except on compulsion.

In former days three **varieties** of erysipelas were described, viz., the cutaneous, cellulo-cutaneous and the cellular. In the first the infection is probably limited to the lymphatics of the skin; in the last (cellulitis), the subcutaneous lymphatic spaces are alone involved, whilst the cellulo-cutaneous variety is probably due to an infection of both. An *idiopathic* form used also to be described, in which the disease starts without any apparent local origin; but when one considers that infection may occur through the slightest abrasion, and even through sound skin or mucous membrane, and that the cocci do not exist, as a rule, in the blood, it is evident that the theory of local infection is in all cases the more probable.

The **Causes** of erysipelas may be briefly stated as follows: (i.) The existence of an abrasion or wound in most cases, and particularly of an unprotected septic wound. Thus, it is not uncommon to find it associated with neglected scalp wounds or with those communicating with the mouth. (ii.) A weak, depressed state of the constitution, as from alcoholism, vicious living, diabetes, albuminuria, etc. Some people, moreover, seem naturally predisposed to the disease, particularly plethoric and gouty individuals, and one attack always seems to render the individual more liable to recurrences. (iii.) Bad hygienic surroundings are a most important additional factor in its production, especially overcrowding in hospitals and bad ventilation. But these are all merely predisposing conditions; the only exciting and absolute cause is (iv.), the infection with the specific micro-organism, which is very widely diffused in Nature. When once an entrance has been effected, the cocci develop in the superficial lymph channels, producing a transient inflammatory condition of the skin, and a concurrent pyrexial state of the individual from the absorption of specific toxines. The organisms are of no great vitality, since it appears that the local reaction which they set up is quite sufficient to destroy them, even whilst they spread peripherally. Immersion for fifteen seconds in a 1 in 30 solution of carbolic acid also ensures their destruction.

The **Symptoms** of the disease are usually ushered in by a slight chill, scarcely amounting to a rigor, and by a period of headache and malaise for about twenty-four hours, with some degree of pyrexia. These symptoms are followed by the development of a bright, rosy-red rash, spreading either from the margin of the wound, or showing itself in apparently unbroken skin in the so-called idiopathic variety. If there is a wound, it usually presents a sloughy and unhealthy-looking surface, with very little evidence of repair. If the erysipelatous virus is unmixed with other organisms, the healing process may continue until the rash appears, when the young cicatrix will break open again, exposing a dry and sluggish surface, with a thickened margin. The *rash* is of a characteristic vivid red colour, always disappearing on pressure, and is accompanied by a sensation of stiffness or burning, scarcely amounting to pain, except when dense structures, such as the scalp, are involved, and then the pain may be very severe. Swelling is not very marked, except in lax areolar tissues, such as occur in the scrotum or eyelids; the œdema may then attain considerable proportions. The rash continues to advance more or less rapidly, with a continuous margin, and as it spreads to new regions it fades away from those already involved, leaving a slight brownish stain and a fine branny desquamation. Vesicles and bullæ form superficially, containing serum, which speedily becomes turbid, but suppuration is uncommon, except in lax œdematous tissues, such as the eyelids. Occasionally, from the severity of the inflammation or the low state of vitality of the tissues, the skin may become gangrenous and slough, especially about the umbilicus and genitals of young children. Neighbouring lymphatic glands are always enlarged and painful, and this may even be noted at a period when the rash has not appeared. Fever is present as long as the rash persists, and merely shows slight diurnal variations. It is not uncommon for the temperature to rise to 104° F., but anything above that is of grave significance. At first the fever is of a sthenic type, the pulse full, and the delirium noisy and active; but later on the pulse becomes quick and weak, accompanied by low muttering delirium and great prostration of the vital powers. Delirium is usually a well-marked feature in erysipelas of the scalp, but this is due to the general rather than to any local condition. The duration of the attack is most variable, lasting, as a rule, from one to three weeks, but relapses are not uncommon.

The so-called **Idiopathic Erysipelas** mainly affects the head, and occurs in predisposed individuals; it is characterized by the great œdema of the subcutaneous tissues of the face, which causes the features to become almost unrecognisable. Large blebs form, and even abscesses about the eyelids. There is a great tendency to recurrence about the same time of the year in these cases, and pain and delirium are prominent symptoms.

Celluło-cutaneous Erysipelas is due to an infection of the skin and subcutaneous tissues with the specific virus, and results in suppuration and sloughing both of the skin and subjacent cellular tissue. The signs are those of a diffuse spreading inflammation, evidenced by heat, pain, redness, and a swelling of a brawny type at first, but which soon softens and becomes boggy, the skin giving way, and allowing exit to the pus and sloughs. The general symptoms are correspondingly severe, and pyæmia or septic intoxication may be also present. As distinguishing features from ordinary erysipelas, it is stated that the margin of the redness is less defined, that the lymphatic glands are less enlarged, and that it is doubtful whether or not the disease is contagious; the whole nature of the affection is still more or less *sub judice*.

Erysipelas of the Fauces is a true erysipelatous inflammation of the mucous membrane of the fauces, tending to spread to the glottis and larynx, and arising either by extension from without, or in association with some external manifestation of the disease elsewhere. The fauces and soft palate become of a dusky scarlet colour, and very swollen. The voice is either husky or absolutely disappears, whilst spasmodic dyspnœa may arise from extension of the œdema to the glottis. There is a considerable tendency for the parts to ulcerate or slough, constituting one variety of 'putrid' sore throat, and the glands at the angle of the jaw are also much enlarged. Severe fever is usually present, and great depression of the vital powers.

Erysipelas of the Scrotum, or, as it is sometimes termed, acute inflammatory œdema, is characterized by the part becoming enormously distended by serum, but without any marked redness. Suppuration and sloughing are not unlikely to follow. It thus somewhat simulates the appearance produced by extravasation of urine, but is distinguished from it by the facts that there is, as a rule, no difficulty in micturition, and that the swelling is not limited in the same way as in the latter affection.

Diagnosis.—There is not much difficulty in recognising a case of erysipelas if we remember the distinguishing features of the rash, viz., its method of extension by a broad, sharply-defined, slightly raised and infiltrated red margin. Thus, the *exanthemata* are never limited to one part of the body, and rarely form one continuous red patch. *Lymphangitis* is characterized by streaks or lines of redness, not by an area of uniform hyperæmia. In *phlebitis* the skin is seldom red over the inflamed vein, which can be felt as a hard knotted cord below. A *septic wound* with pent up discharge closely simulates erysipelas; but the margin of the redness is not so accurately defined, and lymphatic enlargement does not so constantly occur. Diffuse *erythema nodosum* is recognised from it by the absence or slight degree of the febrile disturbance, and the presence of outlying nodular patches of redness, which, moreover, are not so clearly limited. There is always considerable pain in this affection, which often involves both legs, and usually occurs in young women of a rheumatic temperament. The so-called *erythema solare* follows exposure to the sun's rays, especially when reflected from water, of parts of the body which are, as a rule, protected; though usually of slight importance, it may sometimes give rise to so much pain, œdema, and constitutional disturbance as to simulate erysipelas. It is readily distinguished by the facts that it is limited to the parts exposed and has no tendency to spread. In acute *eczema rubrum* the presence of a honey-like exudation is quite characteristic.

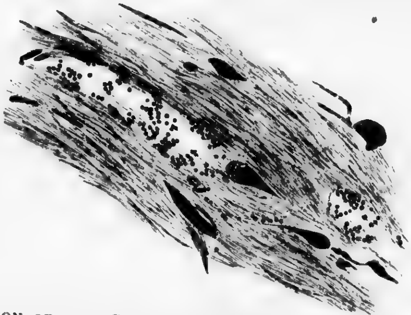

FIG. 14.—SECTION OF THE SPREADING EDGE OF A PATCH OF ERYSIPELAS, SHOWING THE LYMPHATICS OCCUPIED BY CHAINS OF COCCI, WHICH AS YET HAVE PRODUCED BUT LITTLE EFFECT ON THE TISSUES.

Pathological Anatomy.—If a person dies of erysipelas, one merely finds the general signs common to all septic cases detailed elsewhere (p. 91). The rash will have faded, but on microscopic section of the skin colonies of cocci arranged in chains will be found invading the lymphatics just beyond the spreading margin (Fig. 14), whilst in the parts which the inflammation has recently attacked there may be a considerable excess of leucocytes. The lymph glands will also be found enlarged and congested.

Prognosis.—Erysipelas is not peculiarly dangerous in itself, but may become so from the complications which may attend it. The most important of these are inflammatory conditions of the brain, lungs, and other viscera, disease of the kidneys being especially serious. Pyæmia and general septic intoxication may also be met with. Erysipelas of the face and head is often attended with danger to life, particularly in old people, whose vital powers become rapidly exhausted. The same statement is true as regards infants, who have no power of resisting the invasion of the disease. As a local complication, erysipelas is not always an unfavourable occurrence, since wounds which have become chronic and sluggish will sometimes manifest marvellous reparative power after an attack. Chronic lupoid and syphilitic ulcers may rapidly cicatrize, and even malignant sores, especially sarcomata, have been known to be cured.

The **Treatment** of erysipelas is mainly conducted on general principles. *Prophylaxis* must be strictly attended to by observing every antiseptic detail in the treatment of wounds, especially when any erysipelas cases are under treatment at the same time. When the disease is prevalent, all operations that can be delayed should be postponed. Isolated cases should be separated from other patients, and kept out of surgical wards if practicable. If, unfortunately, a case develops in the wards, and cannot be completely isolated, the bed should be placed as far away from others as possible, and especially from those with open wounds, which from their position (*e.g.*, the mouth) cannot be properly protected from sepsis. It is usual to surround the bed with sheets kept moist with carbolic lotion, and the floor around should be sprinkled with the same. Special nurses must be told off to attend to the case, and to it alone, and house-surgeons and dressers must take extra precautions to prevent the spread of the disease.

As to **Local Treatment**, one can merely protect the part from the air, as by painting it with collodion, or covering it with a thick layer of starch or flour, mixed with boric acid or iodoform, or in the more severe cases by applying hot fomentations containing opium or belladonna (*e.g.*, 1 ounce laudanum to 1 pint lotio plumbi). The local application of cold is absolutely harmful, as tending still further to depress the vitality of the part. Where tension and pain are severe, abstraction of blood by scarification with a lancet may be advantageous. Attempts have also been made to cut short the disease by the use of antiseptics applied to the inflamed region, such as painting the part with a lotion of corrosive sublimate, or rubbing into it mercurial ointment; but perhaps the best results have been obtained from thiol, an artificial sulphur compound resembling ichthyol in its characters, but without the objectionable smell. A 20 to 40 per cent. aqueous solution is painted over the affected area as well as over the neighbouring healthy skin several times a day until the fever disappears; such treatment is stated to be usually successful in checking the disease in two or three days.

Pressure seems to be of some value in limiting the spread of the mischief, acting probably by compressing the lymphatics. A wide band of adhesive plaster wound around a limb beyond the margin of the rash is often effectual, and it may be possible in this way to check its onward advance from the scalp to the face or neck.

The introduction of sero-therapeutics has been utilized in this affection with much benefit. An *antistreptococcic serum*, prepared by immunizing a horse with the *Streptococcus pyogenes*, and then withdrawing its blood serum, has been used a good deal, especially in France, where Marmorek and others have inaugurated this plan of treatment. Ten or fifteen c.c. of this serum are given subcutaneously as a dose, and repeated once or twice a day. As a rule, the pain rapidly diminishes, the rash ceases to spread, the temperature falls, and in twenty-four to forty-eight hours the disease is at an end. Although the serum has not been largely used in this country, there can be but little doubt that in the future we shall depend on this rather than on any of the more old-fashioned plans indicated above.

Constitutional Treatment must be of a tonic and supporting character. Good food, easy of assimilation, stimulants and quinine must be freely administered, whilst the tincture of the perchloride of iron in ½ drachm doses, repeated three or four times a day, is still looked on by many as a specific.

In *cellulo-cutaneous erysipelas* early and free incisions must be made to relieve tension, and, if possible, anticipate suppuration. The tissues, when incised, look gelatinous from the œdema present, and much fluid of a sero-purulent type will escape. If this is not undertaken, considerable portions of skin and subcutaneous tissue may slough. Antiseptic poultices should be employed after the incisions have been made, until granulations have formed. Probably here also the antistreptococcic serum will in the future render such treatment unnecessary, if the case is seen early enough.

In *erysipelas of the fauces* the parts must be painted or freely swabbed over several times a day with antiseptic lotions, such as liquor argenti nitratis (30 grains to 1 ounce) or liq. hydrarg. perchlor. (1 in 2,000), whilst a high tracheotomy may be needed if the glottis is involved. Diffusible stimulants and plenty of nourishment are urgently necessary to combat the depressing effects of this disease.

Septicæmia.

Septicæmia is an acute general infective disorder, arising from the development of some variety of pyogenic organism in the blood. It differs from pyæmia in the absence of secondary abscesses (although, as explained later, it may be associated with it), and from sapræmia or septic intoxication by the fact that the latter is merely a chemical toxæmia. In septicæmia, if a minute trace of the blood taken at a distance from the local focus of mischief is inoculated into another animal or individual, the disease is almost certainly transmitted, and often with increased virulence; in sapræmia, injection of the blood, except in large quantities, does no harm.

As to the ultimate *cause* of septicæmia in man, much discussion has arisen owing to the divergence of the results obtained by experimental research. Koch and Davaine have each succeeded in isolating separate bacilli which produce fatal septicæmia in rabbits and mice respectively; but neither of these is necessarily fatal to other animals, and neither is the same as the organisms usually found in human septicæmia, although the symptoms produced are practically identical.

In man various bacteria seem capable of producing this disease under suitable conditions—viz., the ordinary *Streptococcus pyogenes* of acute spreading suppuration; the *Streptococcus septicus* of Flügge, which is probably identical with the above, though more active; the *Streptococcus septopyæmicus*, which is more nearly allied to the erysipelas organism; or even the *bacillus of malignant œdema* (Koch).

If a mouse is infected with its specific bacillus, it remains apparently unaffected for a period of twenty-four hours (incubation stage), but then becomes languid, its eye loses its lustre, it refuses to eat or run about, the respirations become slower, and in about another twenty-four hours it dies, all its functions appearing to be more or less paralyzed. Anatomically, one discovers but few naked-eye changes, except a little local inflammatory exudation at the point of inoculation, and slight swelling of the spleen. Microscopically, many of the red corpuscles are found to be invaded and broken up by bacilli which may even be seen within them, and the capillaries, especially in the lungs, are more or less blocked by aggregated masses of organisms.

The pathological processes in human septicæmia are inferred to be of a similar character—viz., development of organisms in the blood, with disintegration of corpuscles, especially of the red; obstruction to capillaries, particularly in the lungs; formation of toxines as a result of this development; and paralysis of the functions of the nerve centres thereby.

Clinical History.—Septicæmia occurs most commonly from direct inoculation with suitable organisms through small lesions, such as post-mortem wounds, or from scratches or punctures with infected pins or instruments; it also in rarer cases follows operation wounds and severe lacerated injuries. It is the usual accompaniment of acute spreading gangrene, and may be met with in cellulitis and cancrum oris. As a rule, the individual attacked is in a depressed and debilitated condition, often deteriorated by alcoholic or other excesses, so that the inherent germicidal activity of the tissues is markedly insufficient to cope with the inroads of the disease.

The point of inoculation may be the seat of any of the forms of **local** trouble which we have already described under the title of cellulitis, which may vary from a mere slight inflammatory blush to the acutest form of spreading gangrene.

The **General Symptoms** are those of fever, often ushered in by a distinct and severe rigor; the temperature reaches 104° or 105° F., and usually remains high, with but slight remissions and no intermissions. There is great malaise with loss of appetite; the tongue is brown and parched; the pulse is quick and feeble, and the skin, yellow and icteric in colour, becomes dry and hot, or is sometimes covered with perspiration. Diarrhœa often ensues, and may be blood-stained, whilst the urine may be albuminous, and contain blood. Petechiæ appear under the skin, and the patient, after a period of delirium, falls into a state of coma, and dies. Dyspnœa may precede the fatal issue, whilst the temperature may be exceedingly high, or occasionally subnormal.

Illustrative Cases.—A servant girl, aged about twenty-two, complained one hot summer's day that she had been stung near the inner canthus by a fly. Possibly the animal had come from some infected material, and thus poisoned the wound. In twenty-four hours she was feeling ill and feverish, and had some chills and flushes; there was a painful swelling at the inner canthus, which rapidly increased in size and spread downwards. At the end of four days, when we saw her, the eye was protruding and much congested, and a definite band of inflammatory thickening could be felt reaching from the root of the nose across the face to the neck and jugular region, probably the thrombosed facial vein, the clot doubtless also extending to the cavernous sinus. The temperature was high, and the girl was delirious. An incision was made into the orbit with the view of relieving tension and giving exit to any possible pus, but with no result. She rapidly became unconscious, and died within a week.

An elderly man, addicted to drink, fell in the street, and grazed the inner side of his hand Within twenty-four hours the whole arm was puffy and swollen, and in two days gangrene had manifested itself, the infiltration reaching beyond the shoulder. The patient was dead from acute septicæmia in five days.

The **Post-mortem Signs** are simply those of acute septic poisoning, described above (p. 91), with the addition that on microscopic examination bacteria can be demonstrated in the blood and internal organs.

The **Diagnosis** has to be made from *sapræmia* and the more virulent forms of the *acute exanthemata*, in which the patient is destroyed before the characteristic appearances are manifested; in such cases an absolute conclusion as to the nature of the affection is often impossible, if there is no clue as to the origin of the infection. Sapræmia rarely exists unless there is some very obvious focus of putrefaction, whilst septicæmia may occur with but slight local reaction. *Septic traumatic fever*, as associated with wound infection, may be so severe as to cause grave anxiety for a time as to whether or not septicæmia is present; but if the wound is freely opened up and drained, the rapid disappearance of the fever proves that the mischief was merely a local, and not the more serious general, affection. From *pyæmia* it is known by the absence of repeated rigors and secondary abscesses.

Prognosis.—Septicæmia up to the present has been almost always fatal; but it is to be hoped that the modern plans of treatment mentioned below, especially sero-therapy, may prove beneficial in diminishing the mortality.

The **Treatment** to be adopted was formerly merely general and symptomatic. Dealing with the wound is like shutting the stable door when the steed has flown; the case is usually seen too late to allow the surgeon successfully to grapple with the disease, since blood infection has probably already occurred. Inasmuch, however, as the diagnosis from sapræmia cannot always be made with certainty, the wound should be carefully purified, and free drainage provided. Incisions should be made into all infiltrated tissue, in the hope of being able to limit the local activity. In addition to such means, which, after all, hold out but little hope, tonics and stimulants, with plenty of suitable nourishment, could alone be depended on.

It is possible that even this grave disease may become amenable to some of the therapeutic measures which have been suggested of recent years. Thus, the antistreptococcic serum may be utilized, and cases have been already reported as cured by its agency. Another plan which has been adopted is that of the intravenous injection of considerable quantities of normal saline solution, repeated two or three times a day; by this means diuresis and diarrhœa are induced, and it is hoped that thereby the cocci and their products may be eliminated. This treatment has, however, been introduced so lately that no dogmatic statements can be made about it; it will probably be of greater value in cases of sapræmia rather than in those of true infective septicæmia.

Pyæmia.

Pyæmia (Greek *πυον*, pus, and *αιμα*, blood) is a disease characterised by fever of an intermittent type, associated with the formation of multiple abscesses in different parts of the body, arising from the diffusion of pyogenic materials from some spot of local infection.

It was supposed not long ago that pyæmia was due to some specific micro-organism, but it has now been definitely proved by Rosenbach that any of the pyogenic organisms can give rise to it; in fact, *theoretically*, pyæmia may arise as a complication following any acute abscess, which, as we have already seen, is always due to bacterial activity. As a rule, however, there is a sufficiently rapid development of granulation tissue to limit the spread of infection. The organism most commonly found is the *Streptococcus pyogenes*, but in a few cases the *Staphylococcus pyogenes aureus* has been observed. The mere injection of cocci into the circulation is not sufficient to give rise to pyæmia; if they are few in number, a transient pyæmia may supervene, and then the germicidal powers latent in the blood destroy them; but if the dose is large, or the individual is not in a very resistant condition, septicæmia, and not pyæmia, will result, unless special conditions are present which can determine the formation of embolic abscesses. If the cultivation of cocci to be injected is first mashed up with some potato, so that the organisms are carried on particles too large to pass through the terminal arterioles and capillaries, wherever they lodge abscesses are formed. In human pathology the infective emboli consist of zooglœa masses of organisms, or of infected particles of disintegrating blood-clot (Fig. 15).

The **Cause** of pyæmia may be stated to be any condition which leads to the formation and detachment of infective emboli in the circulation, such conditions occurring mainly in the veins from infiltration and disintegration of a thrombus (*septic phlebitis*), but occasionally in the heart (*malignant endocarditis*). The venous contamination which was formerly so much dreaded after operations by surgeons has now been practically banished from surgery by antisepsis. But the disease is still occasionally met with in casualty work, where efficient asepsis is difficult, and in acute infective inflammation of the cancellous tissue of bones, whether idiopathic or traumatic, owing to the veins being abundant and thin-walled, and considerable tension present from the unyielding condition of the surrounding bony structures. Hence, acute necrosis is very commonly associated with pyæmia, as also inflammation of the cranial bones coming on in the course of middle-ear mischief, and leading to thrombosis of the lateral sinus. The presence of large open-mouthed veins in the puerperal uterus also explains the readiness with which the disease occurs after parturition, when septic material is allowed to collect or remain in their vicinity.

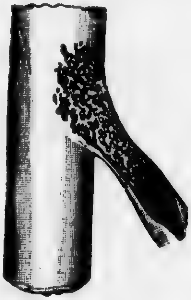

FIG. 15.—DISINTEGRATING CLOT LYING IN A VEIN IN A CASE OF PYÆMIA. (TILLMANNS.)

The apex of the clot projects into a larger trunk, in which circulating blood is present, and from it infected emboli would be detached.

When an infective embolus becomes lodged in any region of the body, a thrombus forms upon it, and in this the micro-organisms rapidly develop, and soon pass from the thrombus into the vessel wall, and thence into the surrounding tissues, causing inflammation, which is at first of a plastic type, but later on becomes suppurative. In the lung many such inflammatory foci may occur, distributed mainly along the posterior border and near the surface; each is sharply limited to a wedge-shaped area of tissue, with the base directed towards the periphery. It is at first reddish in colour, from effusion of blood (a *hæmorrhagic infarct*), but soon becomes grayish-yellow, from the formation of pus. These abscesses are small, and rarely give rise to any physical signs. Similar collections of pus, preceded or not by a stage of infarction, may be found in any organ of the body. The lungs, acting as a filter to emboli derived from the systemic veins, are naturally the first organs to be affected, and from the many abscesses formed therein, infection of the arterial system may take place, resulting in fresh suppurative foci in the liver, spleen, kidneys, brain, and in or around joints, etc. If, however, the causative phlebitis is situated in the portal area, the emboli are lodged primarily in the liver, giving rise to what is known as *pylephlebitis*. If the emboli are many in number, the constitutional symptoms will be severe, and **acute pyæmia** is present; it is usually associated with a development of micro-organisms in the blood, constituting a condition of *pyo-septicæmia*, and then the patient may die before any secondary abscesses have formed; if the emboli are few in number, and there is little or no development of microbes in the blood, the disease is termed **chronic pyæmia**.

Clinical History.—The most marked symptom indicating the onset of a case of **Acute Pyæmia** is the occurrence during a period of febrile disturbance of a severe rigor, which is repeated with a sort of irregular periodicity, most frequently at intervals of about twenty-four to forty-eight hours, somewhat simulating an attack of ague. The rigors do not differ from those occurring in other diseases, but they are very severe, and are usually followed by profuse sweating. Between the rigors the temperature may fall to the normal, but more commonly remains above it. The skin is hot and pungent, and soon develops an earthy or dull yellow icteric tint, together with erythematous or petechial patches. A sweet, mawkish, hay-like smell of the breath is very characteristic. Symptoms of grave depression soon show themselves, and the patient wastes rapidly. The pulse becomes soft and weak, the excretions are diminished, and a certain amount of nocturnal delirium is noticed, but no loss of consciousness. The tongue varies, but is often red with very prominent papillæ, and tends to become dry and brownish. Towards the end of the first week secondary abscesses begin to appear; they are as a rule unaccompanied by local pain or tenderness, and form very rapidly; thus, a knee-joint may fill with pus in the course of a night of quiet sleep. They are, as a rule, small and numerous; if they occur in vital organs, death may result from their local development. When occurring in the superficial soft parts, they are characterized by the almost total absence of a barrier of granulation tissue, and hence, even when opened early and aseptically, have a tendency to extend and continue secreting pus, instead of following the usual course of rapid contraction and repair which succeeds the aseptic opening of an ordinary acute abscess.

Not uncommonly in these cases painful patches occur here and there in the subcutaneous tissue, accompanied by hyperæmia, which fades away after a few days; such are probably due to the impaction of small infective emboli, which the patient has sufficient vitality to get rid of without the supervention of suppuration.

In **Chronic Pyæmia** the febrile symptoms are much less marked; the abscesses are few in number, and not dangerous unless forming in important structures. Thus, a fatal result ensued from a single abscess which developed in the lateral ventricle of the brain of a patient who had no other symptom of pyæmia except an oscillating temperature; it followed an operation on a sinus leading to a kidney already disorganized and highly septic.

The condition of the *wound* at the onset of pyæmia is always very unsatisfactory. If the result of an operation, it will gape and present an inactive sloughy gray surface, and any newly-formed scar tissue will readily break down. A layer of healthy granulations is an almost certain barrier against the occurrence of pyæmia, on account of the germicidal power of the cells constituting it. If the disease arises in connection with bone, the latter structure is usually seen lying bare at the bottom of the wound, denuded of its periosteum, and the cancelli filled with sloughy fœtid medulla, or pus.

The *duration* of a case of pyæmia is very variable. Acute cases last usually a little over a week, whilst the subacute forms may run on for three or four weeks, and chronic cases continue for months, and may even end in complete recovery.

The **Post-mortem Appearances** may be described as follows: 1. The wound is unhealthy, the surface being gray, dry, or sloughy; if bone is implicated, as in an amputation or excision, evidence of inflammatory mischief, either of the periosteum or medulla, will be present. In the bones of the skull the diploë may be infiltrated with pus. 2. The veins leading from the wound may be in a healthy condition, but more commonly are in a state of septic phlebitis; the coats are thickened, and the lumen filled with soft disintegrating clot, which extends for a considerable distance; the tissues surrounding the vein are also involved in the suppurative process. 3. Secondary abscesses are found in various parts of the body, most frequently in the lungs, and their different stages can be clearly demonstrated from the embolic colonies of micrococci, through the stage of hæmorrhagic infarction to the complete abscess. The contained pus may be of the normal type, or thin and oily; it is always, however, swarming with cocci. 4. The general signs common to all cases of septic poisoning will be manifest; they are described at p. 91.

The **Diagnosis** of pyæmia should not be difficult in the majority of cases; but where it originates without any obvious external wound, as in cases of deep-seated abscess, or where the importance of some local lesion has not been appreciated, the initial symptoms have been mistaken for those of acute rheumatism or ague.

The **Prognosis** depends upon the inherent vitality of the patient and the virulence of the disease. In acute cases it is extremely grave, whilst in the chronic type recovery is not only possible, but probable, if the local abscesses are favourably located.

In the **Treatment** of acute pyæmia the surgeon is acting at a considerable disadvantage, in that the disease is only recognisable when it has obtained some hold upon the patient. The recurrent rigors, by which it is known, are the evidence of a grave general infection of the blood, for although only a few emboli may have been detached, any one of them is capable of re-establishing the disease, even if the original focus has been satisfactorily dealt with. By a strict asepsis pyæmia can, as a rule, be prevented; but if in spite of or apart from this the patient develops symptoms, the surgeon must take the most vigorous measures to check its advances.

Local Treatment is most important, and remembering the fact that the disease is in the majority of cases due to the detachment of infected emboli from a vein, the first essential of surgical practice consists in preventing the further contamination of the general blood-stream. This is to be accomplished, in the case of a limb, either by amputation well above the local lesion, or, if the medullary cavity of a bone is the source of trouble, it may be possible to scrape out the gangrenous and offensive medullary tissue, and disinfect the cavity with pure carbolic acid; or if it is due to a wound in the soft parts, it may be feasible to dissect out the implicated vein and surrounding tissues, or at any rate to remove the disintegrating clot after placing a ligature upon the vessel between the thrombus and the heart. A typical illustration of such treatment is that adopted for septic thrombosis of the lateral sinus complicating disease of the middle ear, where, after tying the internal jugular vein in the neck, the sinus is exposed by the trephine, opened, and all the septic clot removed, partly from above, partly from below. Admirable results have been thereby obtained. The *abscesses* must be dealt with, where practicable, by opening them early and washing them out; such wounds often heal well, and even joints which have been distended with pus may recover with free mobility. Occasionally, however, even when rigid asepsis has been maintained, the suppuration continues for a time, and even sloughing of the abscess wall may follow. If the general condition can be improved, a barrier of granulation tissue will form in time, and repair be established.

Constitutional Treatment consists in supporting the patient's strength by nourishing diet and stimulants, and in taking special precautions to avoid bedsores or any local injury. Salicylate of quinine may be administered, though it is doubtful whether it is of much value. The antistreptococcic serum may also be utilized, and doubtless in certain cases which have not progressed too far it might do good.

Tetanus.

Tetanus is a local infective disease, due to the activity of the *Bacillus tetani*, and the characteristic symptoms are of a toxæmic nature. Two varieties have been described, viz., the traumatic and the idiopathic; but it is probable that those cases which might be classed under the latter heading are really due to a subcutaneous trauma becoming infected from within the body, or through some slight abrasion, and therefore we shall not discuss them separately.

Predisposing Causes—1. *Climatic Influences.*—It is most commonly seen in the tropics, where it may become almost epidemic, probably owing to the heat favouring the development and virulence of the organisms in the soil; hot seasons assist its activity, and particularly when hot days are followed by cold nights.

2. *Personal Proclivity.*—It was formerly considered that negroes, horses, and stable attendants were specially liable to this disease, owing to some peculiar idiosyncrasy; but with the recent additions to our knowledge as to the habitat of the *bacillus tetani*, it is extremely doubtful whether such an idea can be maintained. The organism is a facultative saprophyte—*i.e.*, is capable of continuing its development apart from the body—and is almost constantly found in garden soil and dust or dirt of any kind. Those, therefore, who are likely to be much brought in contact with the ground, *e.g.*, negroes, horses, and agricultural labourers, are most liable to the development of the disease, owing to their more constant exposure thereby to the bacillus.

3. *Bad hygiene* is a most important predisposing condition. Every hygienic error may assist in its development, but especially the overcrowding of sick and wounded people into a limited space where full antisepsis is impossible. This is the reason why it is so rife in military surgery.

Exciting Causes.—1. The existence of a *wound*. It may follow a lesion which causes no breach of surface, such as a blow with the fist, or a bruise, but in the great majority of cases there is a definite solution of continuity of the skin. Any region of the body may be thus affected, and there is no elective affinity for one part over another. The old idea that wounds of the web between the thumb and index-finger, or of the ball of the great toe, are certain to be followed by tetanus has no basis in fact, although lacerated septic wounds are extremely common in these regions, and therefore more open to infection. It is rare for tetanus to occur in any but septic wounds, and where asepsis has been fully maintained the occurrence of tetanus is almost unknown.

2. The infection with the *Bacillus tetani.* The first clue to the infective nature of this disease was obtained from the observation that, if portions of soil or garden mould were placed under the skin of animals, they died in a short time with tetanic symptoms, and in the pus and walls of the resulting abscess characteristic bacilli were observed. Experimenting in the same way, it has been found that the bacilli or their spores are very widely disseminated, and, indeed, are present in almost every sample of garden or field-soil; they have even been found in the grime on a working man's hand, and on dirty surgical instruments. Great difficulty was experienced in isolating and getting pure cultures of the bacillus, but at last Nicolaier and Kitasato succeeded, by heating the pus from an infected wound to a temperature of 80° C. for an hour, thereby destroying all the pyogenic septic microbes. It develops in the body as long delicate threads consisting of and breaking up into separate bacilli, in which spores form, usually only at one end, causing such an appearance that the microbe is known as the 'drumstick' bacillus (Fig. 16). They are anaerobic, *i.e.*, flourish apart from oxygen, and, indeed, are best cultivated on nutrient gelatine at blood-heat in an atmosphere of hydrogen. They are not endowed with high vitality, and hence will not invade living tissues unless these have been previously bruised or damaged by the presence of septic inflammation. They grow in the neighbourhood and near the surface of septic wounds, the septic organisms absorbing all the oxygen present, and so originating the anaerobic conditions necessary for their development. The *mode of action* of the bacillus consists in the production of a local infection with general toxæmia; that is to say, by its local development in a wound certain toxic bodies are produced which, when absorbed, act on the spinal marrow and brain, producing toxic effects very similar to those of strychnine. The actual tetano-toxin appears to be somewhat of the nature of a

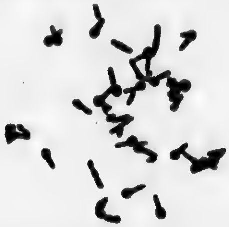

FIG. 16.—BACILLI OF TETANUS FROM ARTIFICIAL CULTURE, SHOWING THE SPORES LOCATED AT THE ENDS OF THE RODS ('DRUMSTICK' BACILLI). (TILLMANNS.)

ferment, its virulence being readily destroyed by exposure to a somewhat low temperature, *e.g.*, one of 68° C. for about five minutes. It is not influenced by drying, and its activity is such that it is stated to be nearly 400 times as poisonous as strychnine.

As to the post-mortem **Anatomical Changes** but little need be said, as there is nothing specially characteristic. The muscles are often pale, or show evidences of rupture and extravasation of blood. The peripheral nerves extending from the wound are red and congested for some distance, but this is probably only due to septic inflammation. The nerve centres frequently present areas of softening, and perivascular cellular exudation, with some hyperæmia.

A few observations are on record in which the bacilli have been noticed on the pia mater and arachnoid of the human spinal cord, and others claim to have transmitted the disease experimentally by inoculation of the subdural space with an emulsion of the spinal cord or medulla. If these facts be true, they indicate that we have still much to learn as to the nature of the disease.

Clinical History.—**Acute Tetanus** usually manifests itself two or three days after infection (but sometimes as early as a few hours, or as late as three weeks) by a difficulty in opening the mouth, associated with a cramp-like pain in the muscles of mastication. This soon becomes so marked that it may be difficult even to insert a paper-knife between the teeth (*trismus*, or lock-jaw), and to it is added a fixed and rigid condition of the muscles of the back of the neck and of the face, the latter producing a curious grin-like appearance (*risus sardonicus*). As a rule, a considerable degree of fever is early manifested, but in some few cases an apyrexial course is maintained until nearly the end. Great difficulty in the administration of nutrition is experienced. Spasms of the muscles around the injured part may be the first sign of the disease, and especially so in experimental work on animals; but soon spasmodic contractions of the trunk and extremities are developed, accompanied by cramp-like pains. When fully established, they may be excessively painful and violent, and the remissions between them but partial. They can be excited by any form of stimulus, such as the slamming of a door, a draught of cold air, or some voluntary movement, and are always of a tonic (*i.e.*, continuous) character. The body is contorted in various directions, and respiration much impeded by the fixation of the thorax. Occasionally the body is arched backwards by the contraction of the muscles of the back, the recti abdominis being firm and tense—'as hard as boards' (*opisthotonos*); sometimes it is doubled forwards (*emprosthotonos*), and in rare cases laterally (*pleurosthotonos*). The muscles may contract so violently as to be ruptured, whilst teeth have been broken and the tongue almost bitten off. The intellectual faculties usually remain clear to the fatal end, which is generally due to exhaustion from a repetition of the convulsions, or more rarely to asphyxia induced by a prolonged fixation of the respiratory muscles. Before death the temperature sometimes runs up to 108°, or even, in one case, to 112° F., and it often continues to rise for a degree or two after death; such hyperpyrexia is mainly due to the continuous muscular contractions. The surface of the body is bathed in sweat, and the urine usually albuminous (from contraction of the renal arteries, according to Cohnheim). Death may occur in twenty-four hours from the onset of the disease, or not for four or five days.

Chronic Tetanus usually begins later after infection, is less severe in its symptoms, and more likely to be recovered from. The course is usually afebrile, and the spasmodic contractions may be limited to the wounded part of the body whence the infection has arisen, or may be general. A special variety of this is known as cephalo-tetanus, or *T. paralyticus* (German, *kopf-tetanus*). It follows injuries within the area of distribution of the cranial nerves, and especially those about the supra-orbital margin, and is evidenced by the association of trismus with facial paralysis, although spasms, both tonic and clonic, occur in other parts of the body. Spasm of swallowing and attacks of maniacal frenzy are sometimes present, and hence the name *T. hydrophobicus* which has been applied to it. The paralysis is supposed to be due to an ascending neuritis of the facial nerve, which becomes compressed in the aqueductus Fallopii. The condition is uncommon, and in the majority of cases fatal.

The **Diagnosis** of tetanus is rarely difficult. In the early stages it must be distinguished from simple *trismus* arising from dental irritation, or from inflammatory ankylosis of the temporo-maxillary joint. This may be readily accomplished by noting that there is also present in tetanus incipient rigidity of the neck muscles. In the later stages *strychnine poisoning* leads to a very similar group of symptoms, but is recognised from it by the contractions being more sudden and violent, the relaxation of the muscles between the spasms complete, so that the mouth can readily be opened, whilst the hands are involved in the contractions, a rare sign in tetanus, and the muscles of mastication often escape.

No difficulty should be experienced in distinguishing tetanus from *hydrophobia*, owing to the very different nature of the convulsions in the latter case—*i.e.*, clonic and not tonic; moreover, they affect the muscles of respiration and deglutition, whilst the history of the case, the early hallucinations, and the absence of tonic muscular contractions, are also characteristic features.

The **Prognosis** is, as a rule, unfavourable in any case, but the so-called idiopathic variety is less fatal than the traumatic. The longer the case lasts, and the lower the temperature, the more likely is the patient to recover, whilst hyperpyrexia, sleeplessness, delirium, and strabismus are bad signs. The length of the incubation period is also a most important factor, since it has been shown that if it is under ten days, only 4 per cent. recover; whilst if it lasts for eleven to fifteen days, 27 per cent. of cures may be expected, and if the outbreak is delayed for fifteen to twenty days, 45 per cent. of the patients may live.

Treatment.—Careful antisepsis applied to wounds is the surest means of *preventing* its occurrence, and the worse the sanitary conditions in which patients are found, the stricter should be the measures employed. In ordinary civil surgery tetanus is exceedingly uncommon, except when following a contused, punctured, or lacerated wound which has not been efficiently dealt with, and especially when mud or dirt has been ground into it.

When it arises from a septic wound which is accessible, either the wound should be freely excised or the limb amputated; but even then the tetanic convulsions may remain for a time, or even prove fatal, from the poison already circulating in the system. Where such measures are impossible, or when the disease is well established, the treatment of the future will probably be the inoculation of a specific tetanus antitoxin (such as that prepared by Tizzoni from the blood serum of an immunized animal). At present the results of this treatment are distinctly disappointing, in that no case of acute tetanus has been saved by it, and the effect even in the more chronic cases is not at all certain. Improvements, however, are sure to be made, and then we may hope for better things.

The explanation of the poor results hitherto obtained lies probably in the fact that the serum is in reality an immunizing agent (*i.e.*, one which prevents the development of the organisms), and is not capable of dealing with the toxic bodies circulating in the blood-stream; so that if a certain dose of the tetano-toxin has once been absorbed, it will produce its normal effects, even though the antitoxin prevents any further development of the organisms.

The ordinary means of treatment consist in keeping the patient absolutely quiet, and free from the advent of all extrinsic stimuli. Food should be nutritious, fluid, and unstimulating; it has been suggested to feed the patient twice a day by a stomach-pump under chloroform. When the trismus is very marked, the patient may be fed through the nose by a Hutchinson's rubber catheter passed into the pharynx, unless there is a sufficient gap between the teeth to admit of its entrance. Opium, chloral hydrate, bromide of potash, physostigma, and curare, have been vaunted as beneficial drugs, but probably cases which have recovered after their exhibition would have done so without. Chloroform may be administered to control the spasms.

Hydrophobia.

Hydrophobia is an acute general infective disease, transmitted from animals to men, especially from rabid dogs, wolves, etc. It consists essentially in an affection of the central nervous system, and one of its most marked features is the long and variable incubation period. It never originates idiopathically either in animals or man, and although the actual virus has not yet been isolated, there can be no doubt that it is a micro-organism. The poison has been shown to exist in the secretion of the salivary glands, in the blood, spinal cord and brain, tear-passages, pancreas and other viscera, and, indeed, appears to be widely diffused throughout the system. Infection most usually follows a bite; but if the teeth pass first through a garment, the virus may be wiped off, and the individual may escape. It has also been proved that if an infected animal merely licks an abraded surface the disease may be transmitted, even when the animal has not at the time shown any of the more typical signs of rabies.

In the **Dog,** rabies manifests itself three to five weeks after infection, but the period varies considerably; the original wound usually heals perfectly, or there may be some inflammatory thickening about it. Two chief varieties have been described—the raging or maniacal, and the quiet or dumb. *Rabies with frenzy* commences with a stage of depression, which is manifested by great snappishness and irritability, especially towards other animals, by a characteristic restlessness, and by the dog moping in dark corners, with a depraved appetite, eating any kind of rubbish or dirt, and even its own excreta. This period lasts for two or three days, and is perhaps the most dangerous, since there is nothing very suggestive about the symptoms. It is followed by a period of frenzy and maniacal fury, and this in turn is succeeded by a stage of paralysis, going on to death. During the whole attack the mouth is filled with ropy saliva, which the animal vainly tries to scratch away; the bark loses its ring and becomes hoarse, and as the disease progresses paralysis of the lower jaw becomes evident; finally, after partial or general convulsions, the animal dies five or six days from the onset. In the *melancholic or dumb form* the animal dies more rapidly, passing through the same stages as the above, with the exception of the maniacal period. The disease lasts but two or three days in this variety.

In **Man** the incubation period of this disease is most variable, lasting from days to months or years, but as a rule it does not exceed six weeks. During this interval the wound heals, although the scar may remain tender and neuralgic. The disease is ushered in by a vague sense of terror, with illusions of the senses and disturbance of the mind, lasting for about twenty-four hours. Restlessness, sleeplessness, loss of appetite, and a repugnance to fluids follow. Perhaps there may be some febrile disturbance, but this is not very excessive. The more characteristic symptoms of the disease are inaugurated by a convulsive stiffness of the tongue, neck, and especially of the muscles of deglutition and respiration, which becomes more marked if any attempt is made to swallow. These convulsions are clonic in character, and thus differ from those of tetanus; they become more and more generalized, being after a time brought on by almost any afferent impulse, however slight—such as a blast of cold air, a flash of light, a sudden noise, especially such as is caused by the movements of fluids; whilst swallowing is quite impracticable. The mouth is usually filled with ropy mucus, which is very difficult to remove. The respirations become catchy, and a hiccoughing noise may be produced by the spasm of the diaphragm, which is sometimes thought to resemble the barking of a dog. Finally, the convulsions may entirely cease, and the patient dies, retaining his consciousness to the end, the fatal issue being due to the destructive changes taking place in the medulla, or to exhaustion; it may, however, occur earlier, from spasm of the glottis. The disease lasts about a week, but may be more rapid, killing even in two days.

The **Post-mortem Changes** are mainly negative. Evidences of acute inflammation of the lower part of the medulla, including the centres for the 9th, 10th, and 11th nerves, are observed on microscopic examination, the vessels being thrombosed, and the connective tissue infiltrated with leucocytes. The nerve fibres and ganglion cells may also be found degenerated. The salivary glands are always somewhat enlarged.

Preventive Measures should be adopted in all cases of bites from dogs which are either rabid or may possibly become so. The circulation in the limb should be arrested by a string or bandage, free bleeding encouraged, and some powerful caustic, *e.g.*, pure carbolic acid, applied. A free excision of the part would, however, be preferable. The importance of such immediate treatment rests on the fact that the infective virus is absorbed with the utmost rapidity. Thus, Pasteur injected some of the hydrophobic poison into the ear of a rabbit, and immediately afterwards cut it off; rabies, however, developed as usual.

Pasteur's Preventive Treatment.—More recently, however, M. Pasteur discovered the fact that the injection of an attenuated virus in increasing doses, and in gradually increasing strength, will protect an animal or individual from the disease, and, *mirabile dictu!* will even catch up the poison already inoculated, and save the patient from its subsequent development, if too long a start has not been given. The method employed is as follows: A virus of constant and maximum intensity is first obtained by passing the poison from a dog through a series of rabbits, until the disease appears with regularity on the seventh day, all parts of the cord being then equally virulent. The material inoculated is obtained by mashing up a portion of the spinal cord or medulla of the diseased dog in sterilized broth, and injecting it with a hypodermic syringe beneath the arachnoid after trephining. All that is now needed is to take a series of these virulent cords, and dry them by hanging in a glass bell-jar with some caustic potash at the bottom for variable periods of time, the virus being thus weakened in its intensity, until at the end of fourteen days it is completely destroyed. Individuals are inoculated with portions of such cords, pounded up in sterilized broth, beginning with the weakest, and gradually increasing the strength of the injection, until a preparation of a cord which has merely hung one day is used. This method of treatment was introduced in 1885, and the results hitherto obtained have been such as to indicate that we have here a most potent preventive agent against hydrophobia. Up to the end of 1893, 14,430 patients had been treated at the Pasteur Institute in Paris, and, excluding cases where the patient died during or immediately after the treatment, only 72 deaths occurred, giving a mortality of 0·50 per cent. instead of 15 per cent., which is the usual death-rate following bites from rabid animals treated in other ways. In all probability, however, the precautions taken in England to enforce muzzling of dogs when any outbreak of this disease occurs is much more promising of good results than inoculation before or after the individual has been bitten. When the disease has attacked an individual, only **palliative treatment** can be adopted. All sources of irritation and disturbance must be removed, and the patient kept absolutely quiet. With a view to diminish the spasms, chloral may be administered internally, or chloroform inhaled, or cocaine sprayed on the fauces. All the nourishment that the patient can possibly take should be administered, with the addition of stimulants. Curare ($\frac{1}{6}$ to $\frac{1}{4}$ grain) every third hour, and mercury pushed to salivation, have also been recommended.

Anthrax.

This disease occurs in man as a result of infection with the *Bacillus anthracis*, which produces in animals, especially in sheep and cattle, the so-called 'splenic fever.' If the microbe is inoculated through the skin, it produces a form of carbuncle known as a 'malignant pustule,' or charbon, although occasionally a condition known as 'malignant' or 'anthrax œdema' arises from the local infection; whilst if it is absorbed by the lungs or intestinal canal, it originates a general inflammatory disorder, known as 'woolsorters' disease,' or anthracæmia.

The *Bacillus anthracis* (Fig. 17) is one of the largest of the pathogenic organisms, measuring 5 to 20 μ in length, and 1 to 1·50 μ in breadth. It is found in the blood of diseased animals in the form of rods or threads, composed of a variable number of individual elements (from two to ten). It is aerobic, immobile, grows best at about blood-heat, and liquefies gelatine. Well-marked spores are formed within the bacillus when cultivated artificially and in the presence of oxygen; but spore formation has not been observed in the living tissues. The bacilli are readily killed by boiling for a few seconds, whilst the decomposition of the carcase in which they are present causes their death in about a week. The spores, however, are very resistant; for whilst a 1 per cent. solution of carbolic acid kills the bacilli in two minutes, the spores remain alive after a week's immersion. Moreover, alcohol, and even a 5 per cent. solution of carbolic acid, have no effect on them. If a mouse is inoculated, say, at the root of the tail with a needle the point of which has been dipped in the blood of an animal which died of splenic fever, it succumbs in less than twenty-four hours, and bacilli are found in nearly every organ of the body.

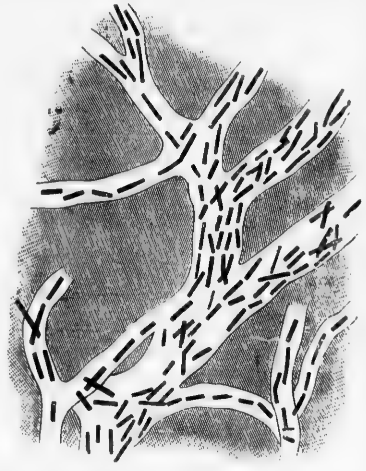
FIG. 17.—ANTHRAX BACILLI LYING IN THE VESSELS OF AN INFECTED PART.

As a rule they are united into rather longer chains than are here represented.

Some animals are immune against the attacks of anthrax, especially the dog and rat; and one of Pasteur's most useful discoveries was that of artificially providing immunity for cattle and sheep by inoculating them with an attenuated virus, obtained by exposing a cultivation for some time to a high temperature.

Symptoms.—Diseases due to the infection with this organism usually occur amongst graziers who tend the living animal, or butchers who deal with the carcase; it is also met with amongst workers in hides or wool.

Malignant Pustule commences as an angry red pimple at the site of inoculation, which rapidly spreads, with much infiltration of the base, whilst the centre becomes covered with vesicles, the serum within which contains the typical bacilli. There is no pain associated with this stage, but only great itching and irritation. As it extends, the central part becomes gray, and finally black, constituting an eschar, whilst around it upon an area of deep brawny congestion and œdema is a narrow ring of vesicles. The process gradually becomes more and more marked locally, whilst the lymphatic glands and vessels are also enlarged and involved in the disease. Generally, there is a certain amount of fever and malaise, which does not become pronounced until about the fourth day. The temperature then rises to 102° or 103° F., the pulse becomes rapid and irregular, the respirations shallow and more and more embarrassed, whilst signs of grave constitutional mischief, including delirium and coma, manifest themselves. If no treatment is adopted, or if it be undertaken too late, the unfortunate individual rapidly succumbs in a state of coma, and generally in less than a week from the onset, but sometimes in thirty to forty hours. Occasionally a case runs a more favourable course, limiting itself to the local manifestations, which gradually clear up, the eschar separating and the œdema disappearing.

When an outbreak of the disease has occurred, a so-called *anthrax œdema* may develop, running on rapidly to a fatal issue. It is usually seen about the face and eyelids, the skin becoming red and brawny, as in erysipelas, and after a time covered with vesicles, whilst finally gangrenous patches appear. The lymphatic trunks and glands are also involved.

Woolsorters' Disease (or anthracæmia) is the term applied to the general condition resulting from the development of these bacilli in the body, where no local lesion occurs. The virus gains access to the system either by the dried spores being inhaled, or through the intestinal mucous membrane. If they enter the respiratory tract, the patient complains of fever and malaise for a few days, and then a sero-fibrinous pneumonia is set up, in the exudation of which the bacilli develop abundantly, and with it a serous pleurisy. This runs a rapid course, with high fever, great dyspnœa, impairment of the circulation, and finally collapse. If the bacilli enter the stomach, they are usually destroyed by the acid chyme; but should any of them or their spores reach the intestine, the alkaline contents form a suitable breeding-ground, and the walls of the gut are soon attacked and the constitution affected. Colic, cramps, vomiting, and blood-stained diarrhœa are the most marked features in such a case.

The **Treatment** must be active and energetic where possible. In the local affection, free excision of the necrotic patch, and of all the infiltrated tissue around, and the application of either the actual cautery or of pure carbolic acid, is the only hope. For the general disease, merely symptomatic treatment can be adopted. Recently, de-emetised ipecacuanha has been much recommended, both as a local application after excision, and also internally in woolsorters' disease.

We now come to a group of diseases which have been classified by Virchow under the term **Infective Granulomata**. They are all characterized by the formation of growths resembling granulation tissue, which either persist or undergo various degenerative changes. They are all infective in nature, and most of them chronic in their progress, although acute manifestations are occasionally met with. Five conditions are included under this heading, viz.: Syphilis, Tuberculosis, Glanders, Leprosy, and Actinomycosis. Syphilis is dealt with elsewhere (Chapter XXXVIII.). The remaining four must be described here.

Tuberculosis.

By tuberculosis is meant a condition resulting from the development within the tissues of the body of certain definite anatomical structures, known as tubercles, and caused by the growth and activity of the *Bacillus tuberculosis*. Before the fact was established that such lesions were the result of the development of a micro-organism, they were usually termed strumous or scrofulous, and even at the present day these two names are occasionally employed to indicate that condition of constitutional weakness which predisposes to the appearance of tubercular manifestations. It is better, however, to avoid the use of such a misleading terminology.

The **Ætiology** of tubercle may be considered under the same four general headings which we have employed elsewhere in describing the causation of various infective diseases.

1. The *individual* is often predisposed to the development of this disease by some inherited weakness or 'vulnerability,' as indicated by the fact that parents, relations, or ancestors have suffered from some similar affection, or that it has occurred in other branches of the same family. Considerable ingenuity has been exercised in describing various forms of physiognomy supposed

to be characteristic of a tubercular inheritance, and although not always present, these appearances are not unfrequently observed. Two chief varieties are described, viz., the *sanguine* and the *phlegmatic*. In the former, the individual is slight and well proportioned, possessing a thin, delicate skin, often freckled, and so transparent that the subcutaneous veins are readily seen. The hair is fine and auburn-coloured, or even reddish, the conjunctivæ thin and pearly, the eyelashes well developed, and the fingers long and tapering. Such children are usually excitable and precocious in their habits, and possess taking manners. The phlegmatic type is characterized by a short, stunted stature, with somewhat coarse features, and strong though somewhat short limbs. The skin is coarse and muddy-looking, the lips thick, the hair rough and brown. Occasionally these two types are conjoined, constituting what is known as 'pretty struma.' In such children of either type there is a considerable tendency to the development of eczema of the skin, inflammation of the mucous membranes, and a subacute enlargement of the lymphatic glands, all of which are simple in nature, but may constitute a suitable nidus for the development of tubercle, especially if the child is run down by some preceding illness, such as measles or scarlet fever. They also suffer frequently from cracked lips, and as a result of the irritation caused thereby considerable infiltration and thickening may follow. Although tubercular disease is most frequently seen in young people or children, no age is exempt from its attacks, even elderly persons being affected by what is known as senile tuberculosis. These senile manifestations differ in no way from those met with in the young.

2. *Unhealthy surroundings and bad hygiene* certainly predispose to its development; hence it is perhaps more commonly seen in the poor than in the rich, although it is not rare amongst the latter, arising usually as a result of improper feeding and want of fresh air in the case of children, and not unfrequently from faulty hygiene or carelessness, especially as to judicious clothing, in adults.

3. A *local nidus* suitable for the development of the micro-organism must, as a general rule, be provided, although tubercular infection occasionally follows wounds and punctures in previously healthy parts. Thus, as already mentioned, lymphatic glands in a condition of chronic hyperæmia and enlargement form a suitable breeding-ground for the bacillus, as also bones and joints which are in a state of congestion as a result of slight and often overlooked injuries.

4. The ultimate exciting cause of tuberculosis is the development within the tissues of the *Bacillus tuberculosis*. This organism, which was originally isolated by Koch, is always present, though not always recognisable, in the products of the disease. It exists in the form of fine straight rods, which are only cultivated

artificially with difficulty, growing best on coagulated blood serum at the temperature of the body, and even then but slowly. The organism gains admission to the system in a variety of ways, either through some abrasion of the skin, or by the digestive tract with some article of food, especially milk, or by inhalation. The contagious nature of the disease has been abundantly demonstrated by clinical and experimental work during the last few years. Thus, it can be readily transmitted by inoculation to animals, especially to rabbits and guinea-pigs, the anterior chamber of the eye of the rabbit being a very favourite spot, owing to the fact that the growth of the characteristic neoplasm can be readily watched, and that spontaneous tuberculosis never occurs in this region. Transmission of the disease to the human subject has frequently occurred from direct inoculation through a puncture or abrasion of the skin, as in the case of surgeons whose fingers have been wounded whilst operating on tubercular cases. Another well-known example is that in which a number of Jewish children were infected with tubercular disease by the Rabbi who performed the rite of circumcision. The bleeding in this ceremony is arrested by suction, and in this case the Rabbi was in the last stage of consumption. Several of the infants died from acute tuberculosis, whilst others developed tubercular ulceration of the penis or tubercular enlargement of the inguinal glands.

Pathological Anatomy.—The tubercular process consists in the development of the so-called gray or miliary tubercles, which tend to run together, and produce larger masses, which in their turn undergo secondary changes, whilst the tissues thus invaded become inflamed and gradually disappear, being replaced by pulpy granulation tissue, in the midst of which the tubercular foci can be seen.

Miliary tubercles can be recognised by the naked eye as grayish, semi-translucent nodules, rarely exceeding a millet-seed in size. The process which leads to their formation almost always commences in or around the small vessels, and can perhaps be best studied in the pia mater. The bacilli are presumably brought to some area of lowered vitality, settling either in the tunica intima or in the perivascular lymphatic spaces. This leads to an overgrowth of the endothelial elements—*i.e.*, to an endarteritis, which may spread for some distance—and this in turn is followed by a proliferation and infiltration of the surrounding connective tissues, resulting in the obliteration of the affected vessel, and the formation of the characteristic tubercular nodule. The *structure* of a fully-developed tubercle (Fig. 18) is as follows: In the centre lies a giant cell, containing a large number of nuclei, which are often arranged around its periphery, or grouped together at one or other pole. Delicate processes extend from the giant cell, and form a fine network, in the meshes of which are situated the cells of the surrounding zone. These are rather larger than ordinary leucocytes, with a granular protoplasm and a clearly-defined oval nucleus. They are known as epithelioid cells, although they are derived from the neighbouring connective tissues, and are, in fact, identical with fibroblasts. Around them are collected a large number of smaller cells, probably leucocytes, and these merge into the surrounding structures, which are gradually changed into granulation or fibro-cicatricial tissue. In many cases the giant cell is absent, and, indeed, it must in no way be looked upon as a characteristic feature of tubercle, since such cells are often met with in syphilis and other conditions where active tissue changes are taking place. Its origin is a little doubtful, but it is probably derived from an enlargement of one connective-tissue corpuscle, or by the union of several such cells. No vessels are present in the tubercular neoplasm, and as a result degenerative changes are certain to follow. Not unfrequently a number of these tubercles develop close together, and under these circumstances the intervening structures disappear, being replaced by granulation tissue, which may in part become further transformed into cicatricial tissue. By the use of appropriate staining reagents it can be demonstrated that bacilli are present in the giant cell, and sometimes in the zone of epithelioid cells surrounding it, but as soon as degenerative changes commence, the organisms can no longer be recognised.

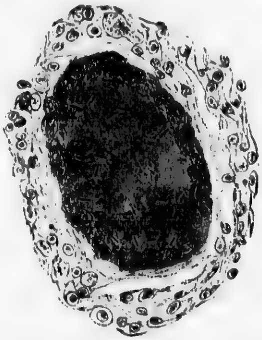

FIG. 18.—TUBERCULAR GIANT CELL CONTAINING NUMEROUS BACILLI, AND WITH THE NUCLEI ARRANGED AROUND THE PERIPHERY. (FROM GREEN'S 'PATHOLOGY.')

The branching processes are not well seen in this preparation. Around the giant cell is a layer of epithelioid cells constituting a fibro-cellular capsule.

If the disease progresses, **caseation** always ensues, owing mainly to the defective nutrition of the part, but also possibly arising from the specific action of the bacillus or its products. Not only does the centre of the miliary tubercle undergo this change, but also the granulation tissue around or between the separate nodules. A caseating focus of yellow or crude tubercle, as it used to be termed, consists of a degenerating centre surrounded by a zone of granulation or fibro-cicatricial tissue, in which are scattered miliary tubercles, and which in turn gradually runs into normal tissue.

The ultimate result of this process depends to a large extent on the general health of the individual and the treatment which is adopted.

1. If the parts are kept at rest, and free from external irritation, and if the constitutional weakness is eliminated by suitable measures, the destructive process may come to an end. In such a case the peripheral layer of granulations is converted into a dense fibro-cicatricial tissue, which forms a sort of capsule, and checks the advance of the disease. The caseous material is either removed by an invasion of leucocytes, or becomes calcified, usually leaving a firm fibrous nodule, perhaps interspersed with calcareous particles. Possibly some of the tubercular material persists in a latent state in this mass, like an 'extinct volcano,' ready to be lighted up into activity if the opportunity is given. In less advanced cases the diseased tissue may be so completely removed as to leave scarcely any trace of its existence behind.

2. More commonly the caseous material is transformed into pus by a process of emulsification, resulting either from the activity of the tubercular organisms, or possibly from infection with ordinary pyogenic or septic bacteria. In such cases a chronic or subacute tubercular abscess results, the structure and characters of which have been already described (p. 43).

One of the chief features of tubercular disease is its great tendency to **diffusion**. This may occur (*a*) *locally*, as a result of direct continuity of tissue, or possibly by its extension along neighbouring lymphatics or bloodvessels; or (*b*) *distant viscera* or organs may become infected, probably as a result of dissemination by the bloodvessels. Thus tubercular phthisis is a not uncommon sequence of a similar affection of bones, joints, or lymphatic glands. (*c*) Moreover, any tubercular lesion may lead to the occurrence of *acute general tuberculosis*, in which the disease is scattered widely throughout the body, giving rise to rapid emaciation, high fever of an intermittent type, and usually severe diarrhœa, dyspnœa, and delirium or coma. A fatal issue follows in the course of a few weeks.

The manifestations of tubercle as it affects **special organs** are dealt with elsewhere under the appropriate headings (see diseases of bones, joints, lymphatic glands, kidney, testis, etc.). In this place it is only necessary to deal with tubercular affections of the skin and mucous membranes.

Tubercular Affections of the Skin—Lupus.—Although the term 'lupus' is usually and correctly applied to a tubercular affection of the skin, yet it is also sometimes employed to indicate any chronic inflammation of the skin which has a tendency to spread, and results in replacement of the cutaneous structures by fibro-cicatricial tissue with or without ulceration. In this place we shall deal mainly with the ordinary **Lupus Vulgaris**, which is almost universally acknowledged at the present day to be of tubercular origin.

It is met with in children and young adults, rarely commencing after the age of thirty. Its most common situation is the face, usually starting at some place where the skin and mucous membrane are continuous—*e.g.*, the alæ of the nose or the inner canthus. It is rare on the scalp, but fairly frequent on the trunk and extremities. The mucous membrane of the nose and mouth is also liable to be attacked, but in such cases the disease usually spreads to it from the skin.

Clinical Features.—The earliest manifestation of lupus consists in the formation of one or more shot-like nodules in the deeper layers of the skin, which are surrounded by a zone of hyperæmia and infiltration. These nodules are not particularly hard to the touch, but when of any size can be demonstrated to be of a brownish-yellow tint, especially if they are compressed by a glass slide, appearing then somewhat of the colour of apple jelly. Gradually the process extends, and usually more rapidly in one special direction, following the course of the vessels. At the same time the integument is gradually infiltrated and transformed into granulation or fibrous tissue, covered by a layer or two of epithelium, and owing either to degeneration of the tubercular nodules, or to a lack of vitality, arising from the compression of the vessels by the contraction of this new formation, ulceration is very liable to follow. In the extremities the lupoid growth not unfrequently takes on a warty aspect, somewhat similar to the 'anatomical wart' occasionally seen on the knuckles of post-mortem porters.

A **Lupoid Ulcer** tends to spread at one margin as it heals at the other, and hence under typical circumstances may be found to be of a crescentic shape, although this is frequently interfered with by various causes. The surface is covered with granulations, often of a protuberant nature. The edges are raised and infiltrated, and scattered lupoid tubercles are readily distinguishable, extending into the healthy tissues, which are usually red and congested. A considerable amount of sero-pus is often secreted, and this by drying forms thick scabs. Any cicatrix which results from natural processes of cure is always thin and very vascular, easily breaking down from any slight irritation. The process extends gradually, and usually slowly, from the seat of its first appearance, being, as a rule, distinctly limited to the cutaneous tissues; but when it attacks the nose, the cartilages are often involved and destroyed, whilst if it extends to the palate or septum nasi, perforation is very likely to ensue. The disease is practically painless, and leads, as a rule, to no deterioration of the general health. Neighbouring lymphatic glands may become enlarged with a tubercular deposit, but this is not a common occurrence. Left to itself, it tends sooner or later to come to an end, the ulcerated parts cicatrizing, but leaving indelible traces of its ravages in the shape of obvious scars, with often considerable loss of substance. Occasionally it may persist, in spite of treatment, and then an epithelioma may in time develop on the site of the old mischief.

Pathology.—Considerable doubt has been expressed as to the tubercular nature of the disease, owing to the fact that it is but rarely associated with tubercular affections elsewhere. All pathologists admit that it is due to a specific bacillus, which is practically indistinguishable from the *Bacillus tuberculosis;* the only difficulty lies in the somewhat distinct clinical history of lupus. On the whole, although the identity of the two diseases cannot be considered to be absolutely established, for practical purposes lupus may be looked on as of a tubercular nature of a somewhat mild type. The characteristic microscopical features of lupus lie in the formation of nodules around the smaller vessels of the skin, consisting chiefly of a mass of round cells, within which may perhaps be observed a giant cell and epithelioid cells,

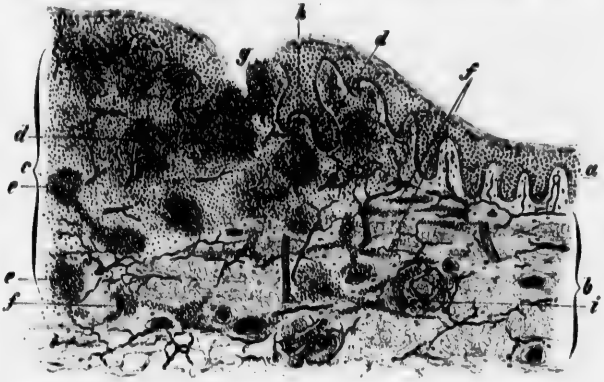

FIG. 19.—SPREADING MARGIN OF A PATCH OF LUPUS. (ZIEGLER.)

a, Normal epidermis; *b*, normal corium with sweat gland (*i*); *c*, focus of lupoid tissue; *d*, vascular nodule surrounded by diffuse cellular infiltration; *e*, non-vascular nodule; *f*, strings of cells in course of lymphatics; *g*, lupoid ulcer; *h*, proliferating epithelium.

arranged in the same way as in tubercle. The structures around are infiltrated and hyperæmic, and as the disease progresses, the original tissue of the part disappears, and is replaced by granulation tissue. The bacilli are by no means readily found, and are always very few in number (Fig. 19).

The **Diagnosis** of lupus from syphilitic and other destructive affections of the skin turns on the presence of outlying nodules beyond the spreading edge of the lesion, together with the apple-jelly-like granulations, and the thin, congested character of any cicatricial tissue present, whilst the slow though continuous progress, and the tendency to heal at one part as it spreads at another, are also suggestive of its presence. The age and character of the individual, and the persistence in many cases of the disease in spite of treatment, must also be taken into account.

The **Treatment** of lupus is often a matter of considerable difficulty. Theoretically, it consists in the free removal of all the diseased tissue, either by the knife, sharp spoon, or caustics. Wherever possible, excision of the whole mass should be performed, the wound being either drawn together by sutures, or allowed to heal by granulation, perhaps assisted by skin-grafting. Such treatment, however, is rarely possible upon the face. More commonly the surgeon has to depend on scraping and the use of caustics. This must be undertaken with a free hand if the whole disease is to be eradicated, since the growth extends beneath the layer of fibro-cicatricial tissue exposed by the spoon. Hence scraping should always be accompanied by the subsequent application of caustics, *e.g.*, solid nitrate of silver, a paste composed of chloride of zinc, pyrogallic acid (5 to 10 per cent.), or even the actual cautery. The wound thus produced should be dressed with an ointment containing iodoform, and allowed to heal by granulation. Outlying nodules may be removed with a sharp lupus spoon, and the little cavity formed in this way covered with chloride of zinc paste; or they may be dug out with the sharpened end of a match dipped in acid nitrate of mercury.

Lupus Erythematosus is a disease the nature of which is not yet satisfactorily determined, some authorities considering it as practically identical with lupus, whilst others agree with Hebra's original dictum that it is merely a form of seborrhœa (Seb. congestiva). The appearance of the affection is tolerably characteristic; it is usually situated on the face, and in the most typical cases symmetrical patches are formed over the root of the nose and cheeks, corresponding in appearance to a butterfly with outspread wings. There is a considerable tendency for it to invade the forehead, ears, and scalp, and occasionally it appears on the trunk, and may then be unilateral. It is evidenced by a smooth hyperæmic surface, covered with a branny desquamation; the scales consist of inspissated sebum, and are continued as deep processes, which can be traced into the mouths of enlarged sebaceous follicles. As the disease spreads peripherally, the older and central portions are transformed into cicatricial tissue of a pale, thin and white type, contrasting very forcibly with the hyperæmic appearance of the advancing margin. It is usually seen in adults, and more frequently in women than men. Progress is exceedingly slow, and ulceration is uncommon.

The **Treatment** consists in attention to the general health, together with the local application of weak tarry and mercurial preparations.

The so-called **Tubercular Ulcers** differ from the lupoid in the fact that they always result from the breaking down of a subcutaneous focus, and hence may be connected with diseases of

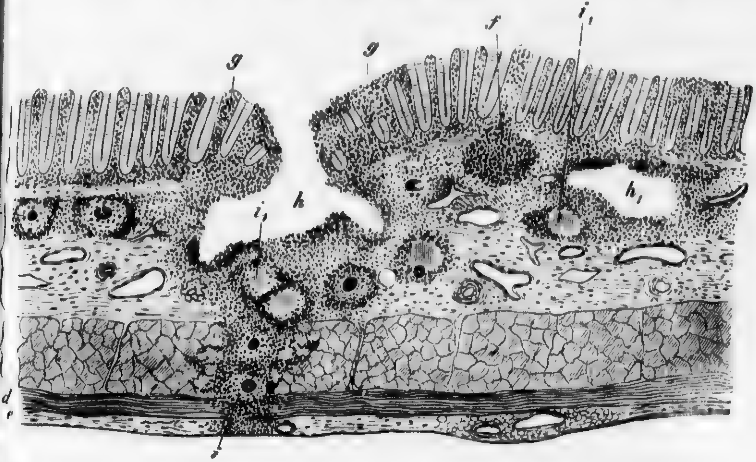

FIG. 20.—TUBERCULAR ULCERATION OF LARGE INTESTINE (× 30). (ZIEGLER.)

a, Mucosa; *b*, submucosa; *c*, inner transverse muscular coat; *d*, outer longitudinal muscular coat; *e*, serosa; *f*, tubercular focus in solitary gland; *g*, mucosa infiltrated with cells; *h*, tubercular ulcer; h_1, focus of softening or tubercular abscess; *i*, early tubercle, with giant cell in centre; i_1, caseous tubercle.

bones, joints, lymphatic glands, or simply of the connective tissues. Whatever their origin, they are characterized by the same features, viz., an irregular and ragged margin with undermined and congested edges; the base is formed by pulpy granulation tissue containing caseous masses of tubercle.

The **Treatment** necessarily consists in the removal both of the unhealthy and undermined skin, and of the tubercular granulation tissue beneath it, the wound being purified by some strong antiseptic, and then dressed with gauze covered with iodoform.

Other cutaneous manifestations of tubercle are described, but need scarcely be mentioned here.

Tubercular Disease of Mucous Membranes may be met with affecting either the alimentary, respiratory, conjunctival, or genito-urinary tracts. It always commences with the formation of tubercular nodules in the submucosa (Fig. 20). As these increase in number and size, caseation follows, and frequently also suppuration, the abscesses bursting through the mucous membrane, and giving rise to shallow ulcers with undermined edges. Where practicable, they should be dealt with in the same way as tubercular ulcers of the skin.

Glanders.

Glanders is primarily a disease of the horse, ass, or mule, which is transmitted to men by direct inoculation, and hence is usually seen only in stable attendants and those brought in contact with animals. It is characterized by the development of inflammatory swellings under the mucous membrane of the respiratory tract, which break down and ulcerate, and by the formation of similar growths, embolic in origin, in the lungs and other viscera.

There is now no doubt that the disease is due to a definite micro-organism, the *Bacillus mallei*, which was isolated about 1882 by Schutz and Löffler, and has since been cultivated outside the body; the experimental evidence as to its being the cause of the malady is quite complete.

In **Horses** and other animals, glanders manifests itself by a formation of larger or smaller rounded swellings in, or by a diffuse infiltration of, the mucous membrane of the nose, and sometimes of the lower air-passages. These break down and ulcerate, giving rise to a thin, sero-purulent discharge, whilst the ulcers may be very extensive, and even cause destruction of the bones and cartilages. The lungs become implicated either by inhalation of the discharge or by embolic infection, and either lobular or interstitial deposits form, which soften and suppurate, as in the case of tubercle. The spleen, liver, and kidneys may be affected in the same way. In addition, the lymphatic glands become enlarged and pass through similar changes, leaving ragged and foul ulcerated surfaces, those under the jaw being first invaded. The same process also involves the lymphatic trunks, constituting the so-called 'corded veins' of farriers, whilst the enlarged glands are known as 'farcy buds.' The disease runs either an acute course, killing in six or twelve days, or is more frequently chronic, lasting perhaps for years.

In **Man**, glanders usually starts about the hands and face, but occasionally in the nasal mucous membrane. In the *acute* cases the incubation period lasts from three to five days, and is succeeded by the occurrence of malaise and febrile disturbance, followed by severe pains in the bones and joints, similar to those in acute rheumatism. The site of inoculation becomes swollen and infiltrated, and suppuration and ulceration follow. The lymphatics leading from this to the nearest glands are enlarged and inflamed. These phenomena are succeeded by a copious papular eruption on the skin, which somewhat resembles small-pox, but each papule goes on to the formation of an ecthymatous-looking ulcer. It is not an uncommon feature of these sores, when placed over a bony surface, to involve the periosteum and lay bare the subjacent bone. Similar changes occur in the viscera, muscles, and joints, and these being associated with high fever of an asthenic type, may suggest the existence of pyæmia. In such cases death may ensue in seven to ten days.

In **Chronic Glanders** similar symptoms are met with, but the course is slower.

there is little or no fever; the disease is less extensive, and intermissions are not uncommon. Total recovery is stated to occur in 50 per cent. of the cases.

It is important to determine the **Diagnosis** as early as possible, in order to undertake energetic local treatment. From *acute rheumatism* it is to be distinguished by the presence of the local lesions, which in turn may be distinguished from *small-pox* by the presence of the characteristic bacilli in the discharge, by the fact that they more extensively involve the subcutaneous tissues, and by the absence of umbilication. The chronic cases resemble syphilis and tuberculosis, but the history of the patients, and their exposure to infection from animals suffering from the disease, is most important, as also the result of cultivations made from the discharge. When the bacilli are grown on potatoes, a colony of a yellowish, honey-like character forms in two or three days, which gradually turns to a chocolate-brown colour.

Treatment can only be of use when undertaken early, and before general infection has ensued. The local foci are to be thoroughly extirpated, either by the knife or by scraping and applying some active cauterizing agent. The same treatment should be adopted in chronic cases.

Leprosy.

Leprosy (*syn.: lepra*, or *elephantiasis Græcorum*) is a chronic infective disease due to the *Bacillus lepræ*, and characterized by the formation of granulation-like neoplasms, which tend to ulcerate, and usually arise in connection with the skin and nerves.

The bacilli of leprosy closely resemble those of tubercle, being 4 to 6 μ long and 1 μ broad (Fig. 21). They are stained by most of the ordinary methods of demonstrating bacteria, and are found in abundance in the tissues; but the disease has not yet been transmitted to animals.

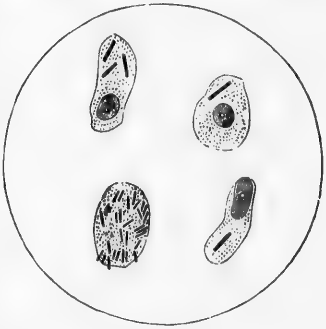

FIG. 21.—LEPROSY BACILLI CONTAINED WITHIN EPITHELIAL CELLS.

Leprosy, though formerly common in this country, is now but rarely seen, and has then usually been imported. In Iceland, Norway, Russia, and in the East, it is still frequently met with, although the compulsory separation of lepers enforced in Norway is much diminishing the number in that country. As to its causation, but little is known; the commonly received idea, that it is associated with an exclusively fish diet, is certainly negatived by the fact that the disease is known to be rife amongst certain races where either fish is forbidden as an article of food or cannot be obtained. It is apparently contagious, though even this is denied by some authorities; and there is considerable difficulty in settling the matter, owing to the unusually long incubation period—perhaps years. Opinions differ also as to whether or not it is transmitted by heredity: and although up to a recent period it was generally conceded that the father could pass it on, even this is somewhat doubtful.

Symptoms.—Two main varieties of leprosy have been described, viz., the tuberculated, and the anæsthetic, or non-tuberculated; but the two are often associated.

Tuberculated or **Cutaneous Leprosy** is the form most commonly seen in Europe. Nothing may be noticed for months or years after exposure to the contagion, and then, after a period of malaise, associated with dyspepsia, diarrhœa, and drowsiness, a distinct febrile attack is noted, lasting for a variable period—from days to weeks. It may be ushered in by a rigor, and the temperature is usually of a remittent type. This is followed by, or associated with, the appearance of shiny, red, hyperæmic spots, which are from the first infiltrated, slightly raised, and hyperæsthetic; they are usually located on the forehead or cheeks, the eyelids becoming œdematous, on the outer side of the thighs, or on the front of the forearms. They may fade away and disappear entirely, and then again become evident, or fresh patches may be developed, and always with febrile symptoms After a variable period 'tuberculation' ensues; numbers of little pink nodules form over the site of one or more of the erythematous patches, and these gradually increase in size and coalesce, until possibly they become as large as a walnut or hen's egg, and then are of a brownish-yellow colour. Almost any part of the surface of the body may be invaded in this manner, but the face is especially prone to be involved, and the resulting disfigurement is very marked, a curious leonine appearance being imparted to the features (Fig. 22). The nodules are usually more or less anæsthetic from the pressure of the infiltration on the nerves, and the ultimate result of the process may vary considerably, since resolution sometimes occurs, or the nodules may be transformed into a depressed and pigmented cicatrix, or ulceration may ensue. Visceral complications and enlargement of the lymphatic glands follow, any fresh deposit being associated with febrile phenomena. The testes atrophy, and sexual power is lost in both sexes. Death is usually due to septic phenomena, laryngeal obstruction, or disease of the lungs or kidneys; but the patient may live for many years.

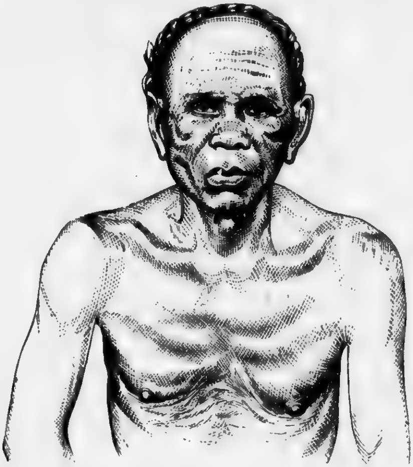

FIG. 22.—TUBERCULAR LEPROSY OF THE FACE.

The nodules consist of masses of granulation tissue, and scattered through them are numbers of large cells, containing multitudes of bacilli (Fig. 21). Considerable difficulty exists in cultivating these organisms, but Ducrey has succeeded by using an alkaline medium, and excluding air.

Anæsthetic, or **Non-Tuberculated Leprosy** is much the most common form met with in hot climates. The earliest phenomena consist in a certain amount of malaise without appreciable fever, together with sharp tingling or lancinating pains along the course of certain peripheral nerves, and tenderness along their course. The ulnar, median, peroneal, and saphenous nerves are those most often affected. This is followed by muscular weakness, running on finally to paralysis, various modifications of sensation, and trophic phenomena, involving at first only the skin, but later on attacking both bones, joints and muscles. Circular yellowish-white patches are observed in the skin, spreading peripherally, and tending to run together, forming large irregular ovals; the border is often raised, and hypersensitive, but the central portions become atrophic, dry, white, and anæsthetic. The anæsthesia gradually spreads, and serious lesions, partly due to trauma, partly arising from trophic changes, result. The muscles atrophy and contract, and give rise to various deformities, the hands sometimes becoming markedly 'clawed,' as in ulnar paralysis (Fig. 23). Interstitial absorption of the bones of the peripheral portions of the limbs may lead the fingers, toes, and other portions to shrivel up and disappear, whilst the joints may become ankylosed. The involved nerves can usually be felt distinctly enlarged and tender. Specific visceral lesions are not so marked in this as in the other form of the disease, and the patient may retain a considerable degree of health and strength, whilst his sexual powers are not much interfered with. Finally he dies from general debility, or from various complications, but the disease may last twenty or more years.

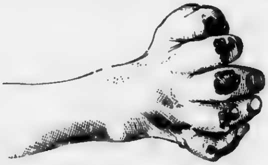

FIG. 23.—ANÆSTHETIC LEPROSY OF THE HAND, PRODUCING CONTRACTION OF THE FINGERS, TOGETHER WITH TROPHIC SORES AND ABSORPTION OF THE PHALANGES.

Prognosis—The disease is almost invariably fatal, although a few cases have been known to recover.

The **Treatment** is still in a most unsatisfactory condition. Chaulmoogra oil, administered both internally and externally, is the drug most frequently depended on, but latterly local injections of sublimate have been employed with some success.

Actinomycosis.

Actinomycosis is a disease mainly of cattle, but occasionally seen in man, due to the growth of the ray fungus (*actinomyces*).

The fungus is transmitted to animals with their food, having been found most often within the husk, or sheath, of barley. It usually attacks the tongue or jaw, turning these into hard infiltrated masses (the 'wooden tongue' of cattle), in which, after a time, suppuration at many foci appears, producing multiple abscesses, which discharge externally, and leave a diffuse inflammatory mass riddled with sinuses. The pus from such abscesses is of the usual type, but in addition contains firm yellowish gritty bodies, which can be isolated by the fingers, and consisting of masses of the fungus. On microscopic examination of these collections, granulation tissue is seen, in the centre of which the clumps of the fungus are arranged in a typical radiating manner (Fig. 24).

In **Man** the disease occurs much more commonly than was expected when attention was first drawn to it, and is probably due to direct inoculation with the fungus from fresh corn which has been chewed or eaten. It has been found in the tongue and maxilla, causing diffuse induration and suppuration; in the lungs, where localized empyemata have resulted; in various parts of the intestinal canal, especially the vermiform appendix; and in the skin. Wherever situated, the same pathological phenomena manifest themselves, viz., either the formation of a localized tumour, in the jaw possibly simulating an epulis, or of a diffuse infiltrating mass, in which abscesses form and open at many spots. The bones are affected equally with the soft parts, and may be rendered carious, and extensively destroyed. In itself the process is not dangerous, but may become so by involving important organs, or by septic contamination. The commonest site for it is close to the angle of the jaw, constituting a cervico-facial tumour, the appearance of which is tolerably characteristic. At first the mass has a smooth, regular, and even surface, and merges gradually into the surrounding tissues; the skin over it is usually hyperæmic. As time passes, little nodular excrescences form here and there on the surface of the tumour, and these finally soften, point, and burst, giving exit to a small amount of glutinous pus, in which the actinomycotic nodules can be demonstrated. When all the fungus has been discharged, the abscess contracts,'and the wound closes. The cicatrization induced by the constant repetition of this process makes the surface of the mass curiously nodular and puckered, and this condition, when present, is almost pathognomonic. Trismus is an exceedingly constant symptom in the cervico-facial form of the disease, coming on early, and being apparently independent of the size of the mass and its involvement of nerves.

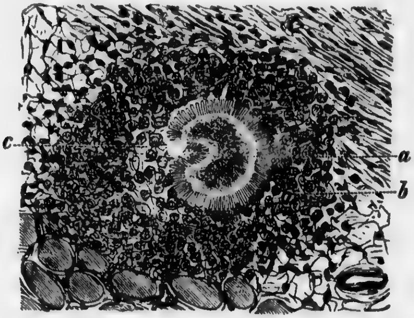

FIG. 24.—ACTINOMYCOSIS OF TONGUE. (TILLMANNS.)

Showing: *a*, the mycelial development surrounded by the club-shaped radiating processes; *b*, a layer of granulation tissue surrounding it; *c*, a focus of commencing suppuration.

The **Treatment** most recently advised consists in the administration of large doses of iodide of potassium, which seems to have almost as great an influence in this disease as in syphilis. At the same time, surgical measures may be employed. Extirpation of all the infiltrated tissue, either by the knife or by vigorous scraping, should be undertaken, and the part freely cauterized; in fact, it must be treated in exactly the same way as a diffuse tubercular mass. This can, however, only be very partially carried out in the visceral affections.

CHAPTER VI.

TUMOURS AND CYSTS.

Although the term 'tumour' is applied generally to any abnormal swelling which may be met with in the body, yet for scientific purposes its application is much more limited. A tumour may be defined as 'a mass of new formation that tends to grow or persist, without fulfilling any physiological function, and with no typical termination.' The fact that it has no typical termination distinguishes it from inflammatory overgrowths, which always tend sooner or later to the formation of fibro-cicatricial tissue, or some modification of it; inflammatory growths, moreover, may disappear completely, and often temporarily diminish in size. Pure hypertrophies are excluded by this definition, since they always depend more or less on some increased physiological function, and are composed of an increased development of normal tissue, as, for instance, the blacksmith's biceps. Congenital overgrowth of a limb or portion of a limb also occurs, and is known as 'gigantism.' It cannot be looked on as of the nature of a tumour, being merely an exaggerated development of normal tissues.

As to the **Causes** of tumours, but little is known. Probably they are all in the first instance local developments, and may be lighted up by some form of **injury** or **irritation**, which determines abnormal development of some of the tissues of the part. Thus, a blow on the breast is often responsible for an adenoma; the irritation caused by smoking a clay pipe may produce epithelioma of the lip, and many other illustrations will readily suggest themselves. Moreover, even if, as supposed by some pathologists, the carcinomata and sarcomata result from parasitic **infection** with psorosperms, it is probable that some local irritation or breach of surface is needed to allow entrance to, or determine the activity of, the organisms; thus, Paget's eczema of the nipple, which is probably an evidence of psorospermosis, is often followed by scirrhus. The **hereditary** nature of some malignant tumours is often mentioned as an evidence of their constitutional origin; but although it may indicate a predisposition of the patient to their development, some local condition may usually be found to determine it. Cohnheim has suggested that tumours may be due to some excessive growth occurring in small portions of undeveloped and undifferentiated embryonic material, or, as he terms them, **fœtal residues**, left among the normal tissues. These may remain in a condition of suspended activity, until some local lesion excites their development. In all these conditions, then, some local irritation is present, and a constitutional dyscrasia or blood change, if present at all, is merely a predisposing factor.

Tumours may be divided into two great classes from a clinical standpoint, viz., the benign and the malignant.

Benign or **Simple Tumours** are characterized by their development being strictly local, by their more or less exact limitation, being frequently encapsuled, and by their method of growth, which results from a proliferation of all the cells constituting their structure. There is no tendency to infiltrate or invade surrounding tissues, which are merely pushed aside and compressed, giving rise to pain and other pressure symptoms, although the tumour itself is painless. The capsule is formed by an ensheathing layer of fibro-cellular tissue, caused by the chronic irritation and inflammation engendered by their growth and development; hence they are usually enucleated with ease, and recurrences are uncommon. They are not unfrequently multiple, and may be hereditary; but these characters are no evidence of a constitutional taint. They never give rise to a fatal issue, except when their continued growth causes pressure on important structures.

On the other hand, **Malignant Tumours**, if not removed by operation, are almost invariably fatal. The following are the chief characteristics of malignancy: (1) The primary growth is usually single, rarely multiple. (2) It tends to progress steadily and constantly, but with varying rapidity in different cases. (3) The local development is characterized by an infiltration of the surrounding tissues, which are gradually replaced by the tumour substance. A capsule is thus rarely formed, or, if at all, only in the early stages, and hence the limits of the growth are not clearly defined. Moreover, many varieties tend to spread locally along the efferent lymphatics, and hence, although the growth may appear to have been completely removed, recurrences are very common, owing to the non-removal of these prolongations (or, as they are termed by the lay public, 'roots') of the disease into apparently normal tissue. If a malignant tumour, with all its ramifications, is completely removed, it does not recur. The impossibility of knowing whether all the growth has been removed, or how far it has extended into the surrounding tissues, is responsible for the frequent manifestation of recurrences. (4) When a malignant tumour invades the skin, it usually leads to ulceration, and then not unfrequently a foul fungating mass may result (the fungus hæmatodes of the older pathologists). (5) Secondary deposits are usually found in neighbouring lymphatics or distant viscera. (6) An apyrexial cachexia is produced, as a result partly of the pain, partly of the pressure of the growth on important structures, interfering with their function, and in part possibly due to the absorption of toxic products developed in the tumour. The patient looks thin and emaciated, the face drawn and with an appearance of suffering upon it; the appetite is impaired, and the skin often sallow and earthy-looking. (7) Finally, death ends the scene, after a longer or shorter period of suffering.

The degree of malignancy varies with different tumours. In some the local phenomena predominate, whilst in others the constitutional symptoms are the more important. Thus, rodent ulcer is slow in its progress, and produces no visceral deposits; it destroys life merely by implication of vital parts. Melanotic sarcoma, on the other hand, may produce only a small primary growth, but the most extensively diffused secondary deposits may form in the viscera. The sarcomata are very frequently disseminated by the blood-stream, and hence secondary growths are not common in the lymphatic glands, whilst the carcinomata spread by means of the lymphatics. Even among the latter considerable differences are met with; thus, in glandular cancer secondary growths occur both in the lymphatics and the viscera; whilst in squamous epithelioma neighbouring lymphatics are affected, but the viscera generally escape. The term **semi-malignant** is sometimes applied to those growths which are on the borderland between the malignant and benign.

The Classification of Tumours is conducted along lines partly anatomical, partly embryological; and on these grounds the following groups are described:

I. Tumours derived from mesoblastic tissue, or, as it may be termed, the **Connective Tissue Group**:

- (1) Embryonic connective tissue tumours:
    - (*a*) Myxoma (mucoid tumour).
    - (*b*) Sarcoma.
- (2) Fully-developed connective tissue:
    - (*a*) Lipoma (fatty tumour).
    - (*b*) Fibroma (fibrous tumour).
    - (*c*) Chondroma (cartilaginous tumour).
    - (*d*) Osteoma (bony tumour).
    - (*e*) Myoma (muscle tumour).
    - (*f*) Neuroma (tumour in connection with nerves).
    - (*g*) Angioma (tumour composed of bloodvessels).
    - (*h*) Odontoma (tumour connected with the teeth).
    - (*i*) Lymphadenoma, or lymphangioma (tumours of lymphatic origin).

II. Tumours derived from epiblastic or hypoblastic structures, or **Epithelial Tumours**:

- (1) Innocent varieties:
  - (*a*) Papilloma (wart-like growth).
  - (*b*) Adenoma (glandular new formation).
- (2) Malignant growths, or the carcinomata:
  - (*a*) Epithelioma (cancer of skin or mucous membrane).
  - (*b*) Rodent ulcer (cancer of sebaceous glands).
  - (*c*) Columnar carcinoma (cancer arising from tubular glands, *e.g.*, Lieberkuhn's follicles, or from ducts lined with columnar epithelium).
  - (*d*) Acinous carcinoma (cancer arising in glands with spheroidal epithelium).

I. The Connective Tissue Group of Tumours: (1) Tumours composed of Embryonic Connective Tissue.

Myxoma.—A myxoma is a tumour consisting of connective tissue cells, surrounded and separated from each other by an intercellular substance of a mucoid character; a similar type of material occurs normally in the substance of the umbilical cord. The cells are usually triangular in shape, and present long branched processes which interlace with those from adjacent cells (Fig. 25).

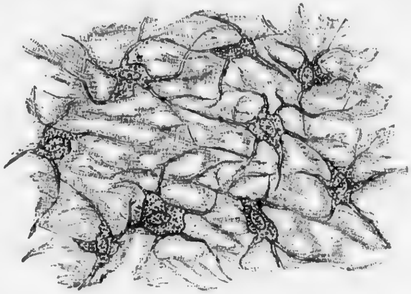

FIG. 25.—MYXOMATOUS TISSUE, SHOWING THE STELLATE CELLS WITH THEIR BRANCHING PROCESSES SEPARATED BY TRANSLUCENT INTERCELLULAR SUBSTANCE. (TILLMANNS.)

The intercellular substance is homogeneous and translucent, containing wandering connective tissue corpuscles, and traversed by bloodvessels; the density of the tumour varies inversely with the amount of this intercellular substance. Myxomata occur as rounded tumours, perhaps lobulated, in the neighbourhood of mucous membranes—*e.g.*, the face, intestine, and bladder; they also grow in the sheaths of nerves, and are the commonest form of simple tumour of the spinal cord. Mucous polypi of the nose are by most surgeons considered to be of this nature, although some rhinologists look on them as merely consisting of œdematous granulation tissue. It is not uncommon for this form of growth to be associated with sarcoma, and hence a thorough and early removal of the mass is always called for.

Sarcoma (Greek, σαρξ, flesh = a flesh-like tumour).—By a sarcoma is meant a tumour formed from some form of immature connective tissue; that is to say, it consists of cells of varying size and shape, held together by a delicate reticulum, which penetrates between each of the cellular elements. The structure is, thus, not unlike that of inflammatory new formations, but differs from it in that there is a considerable tendency to develop into higher types of tissue, such as bone, cartilage, etc., although the embryonic character of the growth still persists at the periphery. From carcinoma it is recognised by the fact that in all except the alveolar sarcomata the structure is more or less uniform, and the cells are not grouped in alveoli separated from one another by stroma; moreover, the intercellular substance does not penetrate between the epithelial cells of a cancer, whereas, with suitable precautions, it can always be demonstrated between the cells of a sarcoma.

A sarcoma always arises from pre-existing connective tissue, and hence is of mesoblastic origin; occasionally, however, it starts from the deeper parts of the skin, but even here it is probably derived from the same embryological basis. It may be at first well defined, and even in some cases encapsuled; but many forms from the first, and all later on, tend to infiltrate the surrounding tissues, replacing them with their own particular structure, a process which can be well observed in sarcomata of muscles. The *blood-supply* is very abundant, and, indeed, may be so free as to cause the tumour to pulsate. The vessels practically consist of spaces or clefts within the tumour substance, and are lined merely by the most delicate endothelium; the arteries and veins in the neighbourhood are also much dilated. Interstitial hæmorrhage is frequently met with, owing to the thinness of the vessel walls, and cysts may in this way be produced; in cases where the hæmorrhage is mixed with the débris of sarcomatous tissue, it may constitute what is known as a malignant blood-cyst. *Dissemination* is usually dependent on the relation of the tumour to the veins. As already stated, the veins are simply spaces hollowed out of the tumour substance; into and along these the sarcomatous tissue may burrow, until the apex of this intravenous growth projects into the lumen of a vessel in which the blood is freely circulating. It is then likely to be detached, possibly as the result of some mechanical injury, and may be carried as a malignant embolus to any part of the body; if a large portion is set free, it may lodge in the right side of the heart, or in the lungs, and cause a fatal result. Smaller emboli are either detained in the lungs, or pass through into the general circulation, giving rise to secondary growths wherever they are arrested; it is quite possible that general visceral implication is secondary to the pulmonary growths. Nothing is known as to the existence of nerves or lymphatics in sarcomata; occasionally, however, dissemination by way of the lymphatic glands is met with, especially in melanotic sarcoma, lympho-sarcoma, and sarcoma of the tonsil, testis, and thyroid body. Various *secondary changes* are apt to occur in the sarcomata, *e.g.*, fatty degeneration, mucoid softening, and hæmorrhage, whilst calcification is not uncommon. Sarcomata are also very frequently accompanied by a growth of cartilage, or even of bone.

On naked-eye examination, a sarcoma presents a more or less homogeneous appearance, the colour varying with the amount of the blood-supply, from a grayish-white in the fibro-sarcomata to a deep maroon colour in the myeloid. On scraping the cut surface, nothing as a rule escapes, except when the tumour has been removed from the body for some time, and thus the cohesion of the cells impaired; a milky juice may then sometimes be obtained; in myeloid sarcoma, a slimy fluid escapes, which in no way resembles that obtained from a cancer.

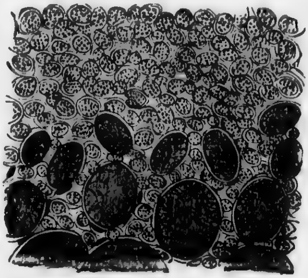

FIG. 26.—SMALL ROUND-CELLED SARCOMA INFILTRATING MUSCULAR TISSUE. (TILLMANNS.)

This form of malignant disease occurs most commonly in young and middle-aged people, especially affecting the first and fourth decades of life; it may also be congenital. The degree of malignancy varies considerably, some forms being almost benign, or, at any rate, only locally malignant, whilst others are exceedingly virulent in nature.

Sarcomata are divided artificially into the following groups, depending on the size, shape, arrangement, and character of the constituent cells: (*a*) The round-celled; (*b*) the spindle-celled; (*c*) the myeloid; (*d*) the alveolar; and (*e*) the melanotic.

(*a*) **Round-celled Sarcomata** (Fig. 26) consist of a mass of round cells containing a very definite circular or oval nucleus; the intercellular substance is slight in amount, and often homogeneous in character. The mass is extremely vascular, and may even pulsate; it is soft, like granulation tissue, and usually grows rapidly. Several subdivisions are described: (i.) The *small round-celled sarcoma* is exceedingly malignant, infiltrating surrounding parts, and early giving rise to secondary deposits; the lymphatic glands are not unfrequently affected in this variety. Any part of the body may be involved, and it may be met with at any age. (ii.) The *large round-celled sarcoma* is made up of larger cells, which contain one or two large oval nuclei with an abundant protoplasm around. A well-marked stroma is interspersed between the cells, and an alveolar arrangement is sometimes present; it occurs in the same position as the former, but is rather less malignant. (iii.) *Lympho-sarcoma* is very similar in structure; the cells, however, are small, and the intercellular substance of a delicate reticular nature, corresponding to the retiform tissue commonly met with in lymphatic glands. Such tumours grow rapidly, and are exceedingly malignant; they usually start in lymphatic glands, or in the lymphoid tissue of mucous membranes, and are disseminated by means of the lymphatics. For the clinical characters of these tumours, see Chapter XI. (iv.) *Glioma* or *glio-sarcoma* is probably a variety of round-celled sarcoma which develops in connection with the nervous system, although there is some little doubt as to whether it should be considered a sarcoma at all. It consists of round cells from which a number of delicate filamentous processes are furnished; they probably originate from the neuroglia, the cells of which they much resemble. Gliomata are found growing from the retina in children, forming tumours which, situated at first within the eye, tend to pass along the lymph spaces surrounding the bloodvessels into the orbit, and also to spread backwards along the optic nerve to the optic chiasma, and thence downwards to the opposite eye, or upwards to the brain. They are also found as primary growths in the cerebral substance, and sometimes in the spinal cord. They have no general malignancy, but may tend to destroy life as a result of their local development.

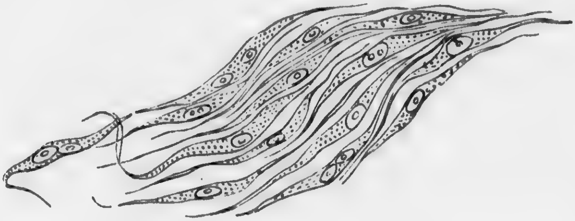

FIG. 27.—SPINDLE-CELLED SARCOMA.

The individual cells have been separated, and the characteristic nuclei can be seen.

(*b*) **Spindle-celled Sarcomata** (Fig. 27) consist of large or small spindle cells, which are often arranged in a somewhat fasciculated manner with a greater or less amount of intercellular substance.

When consisting of *small cells*, the tumour grows rapidly, and is somewhat firmer and less succulent than the round-celled variety. In some cases the intercellular substance is very abundant, and so fibrillated in character as to cause the tumour to be known as a fibro-sarcoma (the 'recurrent fibroid' of Paget). They may originate in any part of the body, but more especially from fibrous aponeuroses, fasciæ, tendons, etc., constituting localized growths, which are at first tolerably well defined, but later on invade and infiltrate surrounding parts. When growing rapidly, the cells tend to become less fusiform in shape, and may even approach to the round cell in character, after passing through a stage known as the oval or oat-shaped sarcoma. These tumours, consisting of small spindle cells, are usually very malignant in character, except when of the fibro-sarcomatous character, and then the tendency to become disseminated is less marked, although there is usually a considerable risk of local recurrence. The *large spindle-celled sarcomata* are softer and of a deeper colour than the former. They grow from the fibrous tissues, and not uncommonly from the viscera. The congenital sarcoma of the kidney is of this nature, though some of the cells become transversely striated, looking like muscle fibres; such tumours are sometimes called 'myo-sarcomata.'

(*c*) **Myeloid Sarcomata** (Fig. 28) are characterized by the presence of large numbers of multi-nucleated giant cells (*myeloplaxes*), imbedded in a considerable quantity of round or spindle cells, the intercellular substance being usually of a gelatinous nature. The myeloid cells vary a good deal in size, but always contain a large number of distinct nuclei, which are not distributed regularly in the periphery of the cell, as in the case of the giant cells of tubercle; they may be regular in outline, or prolonged into numerous interlacing processes, although these latter are usually not very evident. There is also no definite arrangement of cells around them as in the tubercular giant-cell systems. These tumours are soft in consistency, and on scraping a slimy fluid is obtained. They are exceedingly vascular, and may even pulsate. Hæmorrhage into their substance is commonly met with, giving rise to cysts, filled with serum and a yellowish fibrinous clot stained with the colouring matter of the blood. When fresh, the growing edge is of a dark maroon colour on section, and has been likened to the appearance of a pomegranate; when preserved in spirit, they are always of a characteristic brown colour, owing to the formation of hæmatin. They are the least malignant of all the sarcomata, but rarely or never giving rise to secondary growths, either in the lymphatic glands or viscera. Their growth is tolerably rapid, and they may attain enormous dimensions. Myeloid sarcoma is almost invariably found growing from bones; for the particular sites, symptoms, and treatment, see Chapter XVIII. A certain amount of doubt has been suggested recently as to whether these tumours should be included amongst the sarcomata, since their clinical history and progress are so benign, and the term ‘myeloma’ has been suggested for them, as indicating in measure their nature and structure.

(*d*) **Alveolar Sarcoma** (Fig. 29) is a variety in which the cells are grouped together in alveoli, separated by a distinct fibrous stroma. Hence, on microscopic examination they somewhat closely resemble cancer; but on carefully pencilling a section with a camel's-hair brush, it will be found that the stroma sends delicate prolongations between each of the cells. This type of tumour is most commonly found growing from the skin, and is occasionally of the melanotic type. It is always exceedingly malignant.

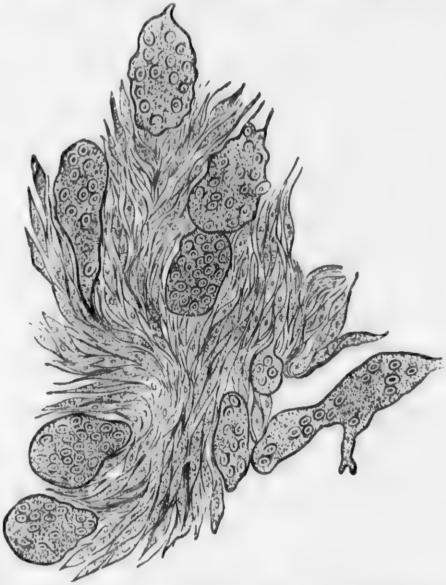

Fig. 28.—Myeloid Sarcoma, showing the Multi-nucleated Myeloid Cells (Myeloplaxes) lying amongst the more abundant Spindle Cells. (Green's Pathology.)

(*e*) **Melanotic Sarcoma** is perhaps the most intensely virulent of all this group of tumours. It almost invariably originates from pigmented structures, *e.g.*, the deeper layers of the skin or the retina. It is, however, sometimes met with growing from the mucous membrane of the lips and gums. It consists of round or spindle cells, often arranged in alveoli, whilst in other cases club-shaped processes of epithelium may penetrate into the subjacent tissues, thus causing them to resemble epithelioma. The most prominent feature is the brown colour exhibited by them, owing to a deposit within the cells of granules of melanin. The amount of this pigmentation varies considerably, some tumours being of a deep brown or brownish-black colour, and then usually consisting of flattened plaques, whilst others are of a more papillomatous nature, and show but slight discoloration, especially if growing rapidly. The growth early spreads to the nearest lymphatic glands, and secondary deposits in the viscera soon follow. So great is the malignancy, that, according to Erichsen, if the primary growth has attained the size of a filbert, local treatment is of but little value. The original tumour is not very large as a rule, and the secondary deposits are similarly characterized by their number rather than by their size, scarcely an organ in the body being free.

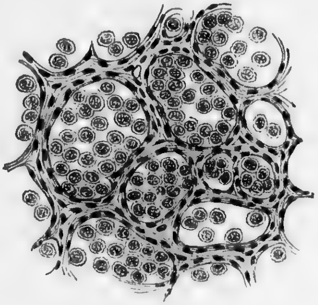

FIG. 29.—ALVEOLAR SARCOMA. (TILLMANNS.)

The individual cells in the alveoli are here apparently lying in close contact, but in reality there is a certain amount of intercellular substance placed between each of them.

Other forms of sarcoma are also occasionally met with, requiring, however, but little notice. In a **Cylindroma**, or **Plexiform Sarcoma**, parts of the growth undergo a mucoid degeneration, leaving columns of cells arranged in a plexiform manner, separated by loose connective tissue containing mucus. It occurs most frequently in connection with the salivary glands and mucous membranes.

The **Treatment** of sarcoma consists in its removal as early and completely as possible. This may be a tolerably simple matter in cases where the tumour is encapsuled, but even here recurrence is very likely to follow unless the capsule is also taken away, and a good margin of tissue beyond it. Where, however, the growth is more diffuse, the only hope lies in cutting widely of the tumour, so as to get beyond its furthest limits; the prognosis of such cases is extremely bad.

In hopelessly *inoperable* cases somewhat similar measures have been employed as for the similar stage of cancer (*vide* p. 163). Several cures have now been recorded from the use of Coley's fluid, which consists of a sterilized culture of the *Streptococcus erysipelatis* and *Micrococcus prodigiosus* in bouillon. This fluid is usually intensely toxic, and the injections, commencing with doses of half a minim, are gradually increased; severe reaction usually follows, and the surgeon should aim at obtaining two or three such effects each week. The fluid is introduced partly into the abdominal wall, and partly into, or around, the tumour. In favourable cases the growth gradually dwindles away. The spindle-celled sarcomata are apparently the most suitable for this treatment, whilst ossifying and melano-sarcomata are but little, if at all, affected.

(2) Tumours consisting of Fully-developed Connective Tissue.

Lipoma.—A fatty tumour consists of a localized overgrowth of fibro-cellular tissue, infiltrated with fat. On microscopical examination it differs in no respect from ordinary adipose tissue, and is not very freely supplied with blood-vessels.

When **localized** (Fig. 30), it forms a tumour, soft and semi-fluctuating in consistence, rounded and lobulated in outline, and if occurring in the subcutaneous tissues, the skin becomes dimpled on moving the tumour from side to side, owing to the adhesion of fibrous trabeculæ passing from the capsule of the tumour to the skin. The growth is usually encapsuled and freely moveable; but if exposed to pressure or friction, as when situated on the shoulder of a man and rubbed by the braces, it may become firmly adherent to surrounding structures. Such growths are either single or multiple, in the latter case perhaps occurring in hundreds, and are most commonly found about the trunk or in the upper limbs. It has been stated that lipomata travel from one point of the body to another by the action of gravity, but it is somewhat doubtful whether this ever occurs. Occasionally subcutaneous tumours become pedunculated and pendulous.

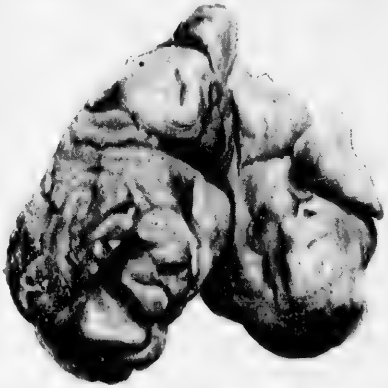

FIG. 30.—LIPOMA, SHOWING CHARACTERISTIC LOBULATED OUTLINE. (FROM KING'S COLLEGE MUSEUM.)

By the term **Diffuse Lipoma** is meant a diffuse fatty infiltration of the subcutaneous parts of some region of the body, especially beneath the chin and at the back of the neck, and often in the pubic region. Sometimes these growths are very numerous, and they are specially characterized by being symmetrical. They usually occur in individuals who drink freely and take but little exercise. Their size often diminishes on limiting the amount of alcohol and making the patient do some physical work.

Occasionally the connective-tissue basis of these tumours undergoes various modifications; *e.g.*, it may become increased in amount, constituting a **Fibro-lipoma,** or it may be transformed into mucoid tissue, thus forming a **Myxo-lipoma**; or, again, the vessels may become dilated, originating a **Nævo-lipoma**; and even a **Sarco-lipoma** may arise, owing to a sarcomatous change involving the connective tissue.

Localized or diffused overgrowths are often met with in the sub-peritoneal fatty tissue, constituting **Subserous Lipomata.** They occur not unfrequently in the lower part of the abdomen, and have a tendency to extend into the inguinal and crural canals, constituting the so-called fatty tumour in these parts. By their traction a process of peritoneum may eventually be drawn down, and a true hernia produced. A similar condition also arises in the anterior abdominal wall, small pedunculated masses of fat projecting through congenital or acquired openings in the linea alba or linea semilunaris. They are sometimes known as **Fatty Herniæ of the Linea Alba,** and are usually extremely painful, owing to the implication of the peritoneum.

Lipoma Arborescens is the term applied to an outgrowth of fatty tissue forming a number of delicate villi, which is met with in the interior of joints, and is usually associated with osteo-arthritis. There is often a considerable increase in the amount of intra-articular fluid, and the condition has then been designated 'synovitis lipomatosus.'

The **Treatment** of lipomata consists, as a rule, in their removal. When they are loosely encapsuled, this is a very simple matter; but if there are many adhesions it may not be so easy. In the diffuse forms, it is of very little use operating, dietetic and hygienic measures being substituted. Liquor potassæ, administered internally, has been recommended, but we have no experience of its use. Occasionally, an operation may be called for, and then it is wise to cut through the whole thickness of the tumour at once, and deal with each half separately, dissecting it away from its deep attachments.

Fibromata consist of overgrowths of fibrous tissue; they were formerly divided into two groups, the **hard** and the **soft,** and although there is no essential difference between them, it is a useful clinical distinction.

The **Hard Fibroma** is composed of firm dense tissue, which creaks on section with the knife, the exposed surface showing numerous trabeculæ of glistening fibres, similar in character to those met with in a tendon. Microscopically, interlacing fibrillæ are seen, which are sometimes arranged concentrically around the blood-vessels; there are but few nucleated cells in the more slowly growing tumours. The vascular supply is, as a rule, defective, although dilated veins are sometimes present, especially in the capsule, and these, if opened by ulceration, may lead to profuse hæmorrhage, owing to the walls being kept open by the dense fibrous tissue. Hard fibromata are met with in the form of *epulis*, *fibrous polypus of the nose*, *keloid*, and as the so-called *painful subcutaneous nodule*. This latter condition is more common in women than men; it consists in the formation of many small subcutaneous tumours which are evident rather to the touch than to the eye, and are often exquisitely painful. No connection with nerve fibrillæ has been traced, although such probably exists, and the pain ceases immediately on removal of the tumours.

Soft Fibromata develop as localized overgrowths of the subcutaneous fibro-cellular tissue, or as the so-called **Molluscum fibrosum** of the skin. In the latter case many different forms of the growth are met with; sometimes a development of small nodules occurs, scattered widely over the surface, usually pinkish, and with the skin over them somewhat corrugated; these may be associated with fibrous pseudo-neuromata of the neighbouring nerves. It may also exist in the form of pendulous folds, perhaps involving a large area of the trunk; the so-called pachydermatocele of the scalp is of this nature.

Chondroma.—Cartilaginous tumours are met with growing either in connection with bones or in certain soft tissues. They consist of hyaline cartilage, which, instead of being uniform in texture and devoid of vessels as at the articular ends of bones, occurs in the form of pellets or nodules of varying size, held together by vascular connective tissue, which may even penetrate into the substance of the cartilage. The cells are also less regular in shape than is the case with normal cartilage, and are not arranged according to any definite plan.

Chondromata are liable to become calcified, and even ossified. When large, the central parts may undergo a mucoid change, giving rise to a cavity which, if sepsis is admitted, becomes exceedingly foul. They are not uncommonly accompanied in their growth by sarcomatous and other elements.

When growing *from the long bones*, chondromata usually start from beneath the periosteum, and are independent of the epiphyseal cartilage, although it has been suggested by Virchow that they may originate from a nodule of cartilage which has been displaced from its usual situation during an attack of rickets. They constitute firm lobulated encapsuled tumours, and give rise to no pain, except when they encroach on neighbouring nerves. They often attain a great size. The growth may extend secondarily into the medullary canal, and thus cause true enlargement of the bone; or it may erode the compact tissue, and cause spontaneous fracture. Amputation of the limb will probably be called for, unless the case comes under observation in the early stages, when the tumour can be gouged or scraped away.

They may also originate *from the smaller bones*, and then usually from those of the hand or foot (Fig. 31). In such cases the growth commences in the interior of the bones, and frequently from the neighbourhood of the epiphyseal cartilages; several tumours may be present in the same individual. The bone becomes expanded by the growth, and the parts may become much deformed. Treatment consists in incising the capsule, and scooping out the cartilaginous tissue, a proceeding which may result in subsequent defective growth and deformity.

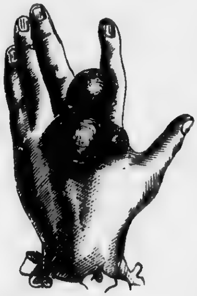

FIG. 31. — MULTIPLE CHONDROMATA OF THE FINGERS.

Chondromata are also found *in the soft parts*, especially affecting the parotid and submaxillary glands, and the testes. In the parotid gland they are usually associated with mucous and fibrous tissue, a few glandular elements being also found embedded in the mass. They develop from the capsule of the gland, or immediately beneath it, and are, as a rule, simple in nature, though occasionally they may become sarcomatous. Submaxillary chondroma is frequently an almost unmixed cartilaginous tumour, though sometimes other tissues may co-exist.

Overgrowths of cartilage, known as **Ecchondroses**, also occur around the articular cartilages in connection with osteo-arthritis; they occasionally arise from the cartilages and septum of the nose, and from the laryngeal cartilages. Some of the loose bodies which form in joints are of a similar nature.

Osteoma.—Bony tumours are of two chief forms: the cancellous and the ivory.

Cancellous Osteomata are usually met with growing near the articular end of a bone, being derived originally from the epiphyseal cartilage (Fig. 32). They consist of cancellous bone, and are capped by a layer of hyaline cartilage, from which they grow. They may be pedunculated or sessile, and may attain to a large size. They necessarily develop in young people, and may be congenital. As the individual grows, the basis of attachment may become separated from the epiphysis to an extent corresponding to the amount of growth which has taken place at that spot, or it may still remain attached to the epiphyseal line. As a rule development ceases at maturity, when the cartilage covering them, as well as the epiphyseal cartilage, ossifies. A bursa occasionally forms over the most prominent part of these tumours as a result of friction or pressure, giving rise to the condition known as **Exostosis Bursata**; this cavity may communicate with the joint. Occasionally an effusion of blood or serum into the bursa is the first evidence of the existence of such a growth. Multiple exostoses are not unfrequently met with, and are then generally hereditary. The commonest situation for such a tumour is the inner condyle of the femur, close to the adductor tubercle. An exceedingly troublesome variety is the **Subungual Exostosis** (Fig. 33), which develops as a rounded, cherry-like swelling under the nail of the great toe. It is very painful owing to the density of the tissues involved, and should be treated by removing the nail, incising the tissues over it down to the bone, and clipping it away with cutting pliers. Fig. 34 represents a skiagram of an exostosis growing from the proximal phalanx of the thumb, and illustrates the value of this process from a diagnostic point of view.

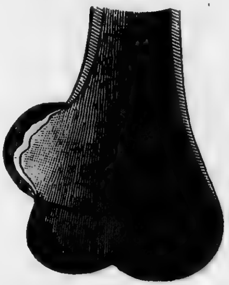

FIG. 32.—DIAGRAMMATIC REPRESENTATION OF CANCELLOUS EXOSTOSIS GROWING FROM THE LOWER END OF THE FEMUR.

Its connection with the epiphyseal cartilage is clearly indicated, as also its cartilaginous covering and the bursa which occasionally lies over its summit.

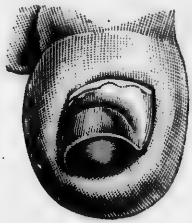

FIG. 33.—SUBUNGUAL EXOSTOSIS. (BLAND SUTTON.)

The **Ivory Exostoses** develop most frequently on the inner or outer aspect of the cranial bones, especially tending to affect the orbit, external auditory meatus, frontal sinus, and antrum (Fig. 35). They consist of masses of compact tissue, covered by periosteum, from which they grow. They are usually lobulated, and when situated in the frontal sinus, or growing from the under surface of the skull, may give rise to serious symptoms from irritation or compression of the brain or its membranes. In a few cases necrosis has resulted, and they have sloughed out, thus bringing about a spontaneous cure.

New formation of bone occasionally occurs in the substance of tendons which are exposed to irritation or excessive action, *e.g.*, the tendon of the adductor longus in riders, producing what is known as 'the rider's bone.' Occasionally diffuse overgrowth of the bones of the skull (**Hyperostoses**) may occur, affecting either the calvarium alone, being then probably syphilitic in nature, or the facial and cranial bones as in leontiasis ossea.

The **Treatment** of osteomata consists in their removal where possible. This may be tolerably simple in the case of the cancellous osteomata of the limbs, but is sometimes a most formidable proceeding when dealing with sessile compact exostoses from the calvarium.

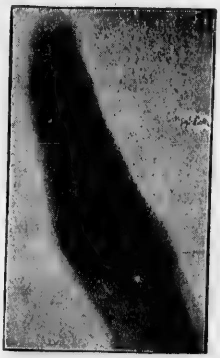

FIG. 34.—SKIAGRAM OF EXOSTOSIS GROWING FROM THE BASE OF PROXIMAL PHALANX OF THUMB, SHOWING OPEN CANCELLOUS TEXTURE AND ORIGIN NEAR THE EPIPHYSEAL CARTILAGE.

Myoma.—Myomata almost always consist of *unstriped* muscle fibres (**Leiomyoma**), forming rounded and often encapsuled tumours, the cells of which are long and fusiform, and contain a rod-like nucleus. Bundles of these cells are grouped together into fasciculi, which are arranged more or less regularly. The tumours themselves are not very vascular, but vessels of considerable size are found in the capsule. It is exceedingly difficult to distinguish these tumours microscopically from fibromata on the one hand, and from fibro-sarcomata on the other. From the former they are known by the fact that individual cells can be recognised, and by the absence of wavy tendinous fibrillæ, whilst from the latter the distinction is even more indefinite; hence one must mainly depend on the clinical history of the case. Possibly other types of tissue may occur in the sarcoma, whilst the growing edge is usually more or less embryonic in character; a myoma is of the same structure throughout. Again, in a myoma the bloodvessels have distinct and definite walls, whilst in a sarcoma they are simply clefts or passages in the tumour substance.

Myomata are met with in the walls of the alimentary canal, but most frequently in the uterus and prostate. In the latter they originate immediately around the sinus pocularis, and are thus analogous to the uterine fibro-myomata. Secondary changes sometimes occur in them, *e.g.*, mucoid softening, as in fibro-cystic disease of the uterus, calcification, ulceration with profuse hæmorrhage, and possibly consequent septic inflammation, whilst occasionally malignant disease may supervene. For the characters of the prostatic myomata, see Chapter XXXV.

Tumours consisting of *striped* muscular fibres (**Rhabdomyoma**) have been described, but are exceedingly rare. Occasionally some of the cells of a sarcoma show a transverse striation, especially in the congenital sarcomata of the kidney. It is quite possible that they represent muscle fibres, since these growths behind the peritoneum are closely associated with the layer of muscular substance which is known to occur there in infants, and of which the gubernaculum testis and muscle of Treitz form parts.

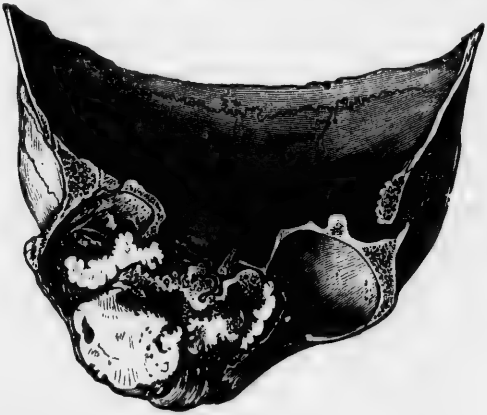

FIG. 35.—IVORY EXOSTOSIS GROWING FROM FRONTAL SINUS, AND ENCROACHING BOTH ON THE ORBIT AND THE CRANIAL CAVITY. (BLAND SUTTON.) (From specimen in the College of Surgeons' Museum.)

Neuroma.—Tumours consisting essentially of nerve fibres are so rare that they need no special mention here; but several forms of neoplasm are known to start from the sheath of a nerve, and hence are sometimes called **Pseudo-Neuromata.** The most common of these consist of fibrous or myxomatous growths, which may either develop from the side of a nerve, or when large may cause the nerve fibres to be separated and spread out over them (Fig. 36). They form well-defined and moveable tumours of varying density, and may give rise to considerable pain of a neuralgic type, especially when compressed or irritated. They move more freely in a direction at right angles to the axis of the nerve than along its course. When multiple they may be associated, as already mentioned, with the development of cutaneous fibromata (*molluscum fibrosum*).

A curious condition, known as a **Plexiform Neuroma**, is sometimes met with, due to a diffuse myxomatous change in the sheath. The nerves become thickened, tortuous, and vermiform, of soft consistency, and looking on section something like the structure of the umbilical cord. The condition is usually congenital, and may attain to such a size as to cause deformity. Malignant disease of a myxo-sarcomatous type may also occasionally occur.

The bulb formed upon the proximal end of a nerve after its division is also sometimes described as a neuroma (**Traumatic Neuroma**). It consists of a mass of fibro-cicatricial tissue containing spaces, coiled up within which are found prolongations of the axis cylinders. They are practically always present in amputation stumps, and are not painful unless adherent to the periosteum of the neighbouring bone, or to the cicatrix, when every movement of the nearest joint causes traction upon them, and may induce severe neuralgia.

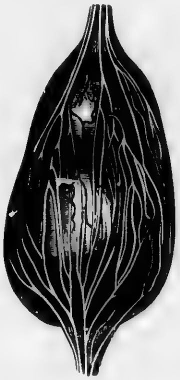

FIG. 36.—PSEUDO-NEUROMA: FIBROUS TUMOUR GROWING FROM NERVE SHEATH, AND CAUSING THE FIBRES TO BE WIDELY STRETCHED OVER IT.

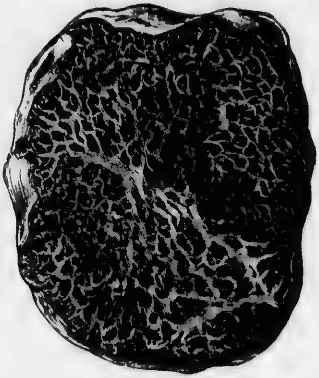

FIG. 37.—SECTION OF CAVERNOUS ANGIOMA.

Treatment.—Neuromata, if painful, should be removed, care being taken, where possible, not to interfere with the continuity of the nerve fibrillæ. If this cannot be accomplished, an attempt must be made to unite the divided ends by immediate nerve suture. When multiple, total removal is well-nigh impossible.

The plexiform neuroma if limited in extent may be dissected out, but if widely diffused throughout a limb it may necessitate amputation.

Angioma.—Several distinct varieties of tumours consisting of bloodvessels occur in surgical practice, but the term angioma is only applied to those in which a new formation of bloodvessels occurs; hence varicose veins and aneurisms are not included in this category.

Three main varieties of angioma may be described: (1) The simple nævus; (2) the cavernous nævus; (3) the plexiform angioma.

The **Simple Nævus** is exceedingly common, and consists of a mass of dilated capillaries, bound together by a small amount of connective tissue. It is often congenital, and may increase rapidly in size during the first few months of life. It is located in the skin, or may also involve the subcutaneous tissues, but the tubular form of the constituent vessels always persists. It may be of a bright red colour, consisting mainly of arterioles, or of a dusky tint if the venules predominate. For a fuller account see p. 300.

The **Cavernous Nævus** consists of dilated spaces, where the tubular form of the constituent vessels is lost, the arteries usually opening directly into thin-walled cavities lined with endothelium without the intervention of capillaries (Fig. 37). The tumours are thus more or less erectile in nature, somewhat resembling the corpus cavernosum. They are sometimes met with in the skin and subcutaneous tissues, constituting diffuse or circumscribed tumours of a bluish colour, which can be emptied on pressure, but rapidly refill when such is removed. Pulsation is occasionally present. A similar condition also arises in the viscera, especially the liver. They are always acquired, and it is not difficult in suitable cases to demonstrate that they have been formed by a dilatation of the capillaries between the lobules, the liver substance meanwhile disappearing by a process of simple atrophy. Occasionally a cavernous angioma may undergo a process of spontaneous cure as the result of some inflammatory affection similar in nature to phlebitis, a non-vascular fibro-cystic tumour remaining. For treatment of nævi, etc., see p. 301.

Under the term **Plexiform Angioma** may be included the cirsoid aneurism, or aneurism by anastomosis, the former term being applied by some authors to tumours consisting of large vessels, and the latter to a congeries of small vessels. It is most commonly seen about the scalp and face, as described in Chapter XXI. Its treatment is a matter of considerable difficulty.

Odontoma.—Tumours originating from some abnormal condition of the teeth or teeth germs are known as 'odontomes.'

Bland Sutton, in his book on tumours,* has described seven different varieties, several of which are, however, rarely met with in man. We can only deal here with the more important of these, and must refer our readers to Chapter XXII. and to Sutton's original work for a fuller description. (1) **Epithelial Odontome**. In this condition, formerly known as fibro-cystic disease of the jaw, the mandible is most commonly affected. A tumour forms, consisting of spaces lined by epithelium, which are developed as irregular outgrowths from the enamel organ. They occur most frequently in young people, and may give rise to growths of an enormous size. (2) **Follicular Odontomes**, or, as they are often termed, 'dentigerous cysts,' are produced by the development of a cavity around a misplaced or ill-developed tooth of the permanent set, which often lies horizontally, so that eruption is impossible (Fig. 231). (3) **Fibrous Odontomes** are the result of a thickening and condensation of the connective tissue around a tooth sac. They are most frequently observed in animals, but are also said to occur in rickety children. (4) **Radicular Odontome** is the term applied to a tumour composed of cement, developing at the root of a tooth. It gives rise to severe pain, and may result in serious septic inflammation of the surrounding bone. (5) **Composite Odontomata** consist of a conglomeration of the various forms of tissue entering into the formation of a tooth, and developing in the neighbourhood of the jaw. They may be very large, and probably some of the bony tumours described as osteomata of the antrum are of this nature.

Lymphadenoma and Lymphangioma.—The primary tumours developed from lymphatic glands are described in Chapter XI., as also the conditions arising from the dilatation of lymphatics.

II. Tumours derived from Epiblastic or Hypoblastic Structures.

Such are either innocent or malignant in nature, the innocent tumours being the papillomata and adenomata, and the malignant, the carcinomata.

Papillomata consist in an outgrowth of the papillæ of the skin or mucous membrane, which may be simple in nature, or composite from the development of lateral offshoots, giving rise to a cauliflower-like mass; they may be sessile or pedunculated. The connective tissue of the papillæ, with its vessels, also extends into the growth, which is sometimes exceedingly vascular. There is no tendency, however, for the epithelium to dip down into the subcutaneous or submucous tissue, the growth being only centrifugal in development, and not at all centripetal, as in the case of the epitheliomata. Not infrequently, however, a papilloma which

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[*] Bland Sutton, 'Tumours and Cysts.' Cassell and Co.

has become irritated may take on malignant action. Clinically, a papilloma is distinguished from an epithelioma by the base being free from infiltration.

Papillomata of the skin are met with in the form of hard excrescences, such as warts or corns; but if growing from moist parts, as from the prepuce, they may be soft and vascular—*e.g.*, venereal warts. Occasionally warts may grow to such an extent as to constitute horn-like projections or cauliflower-like growths.

Papillomata of the mucous membranes are usually villous in character, constituting long, fimbriated tufts, covered with a thin layer of squamous epithelium, and containing delicate bloodvessels, which readily give way, and may lead to considerable hæmorrhage. They are most commonly met with in the bladder, but occasionally in the pelvis of the kidney, on the intestinal mucous membrane, or the rectum. They also occur on the true vocal cords, and are then wart-like, and hard in consistency. Growths of a very similar nature, but somewhat more solid in texture, are found within the ducts or acini of glandular viscera, such as the breast. Condylomata and mucous tubercles, as met with in the course of syphilis, are also of a papillomatous nature.

Adenomata consist of new growths arising in connection with secreting glands, and in structure simulating somewhat closely the organs from which they arise. They differ from them, however, by the facts that they are incapable of producing the characteristic secretion, that they are devoid of ducts, and that the mimicry is incomplete, since the alveoli are less perfectly developed, and may be entirely occupied by several layers of epithelial cells. There is, however, no tendency for the epithelium to pass beyond the basement membrane into the connective tissue, and hence they also are distinguished from cancerous tumours by the new formation being centrifugal, and not centripetal, in its growth. A variable amount of connective tissue is always present, and may be normal in texture, or may manifest various modifications. Adenomata are frequently encapsuled, being merely connected with the original gland by a pedicle, through which the vessels enter; or they may be of a diffuse nature. When growing from mucous membranes, they are sometimes pedunculated, as in the so-called polypus recti. The alveoli in some cases become distended with effusion, giving rise to a cysto-adenoma or adenocele. They are absolutely free from malignancy, except when, as occasionally happens, the connective tissue undergoes sarcomatous changes. When of large size, they may give rise to serious symptoms by compression of important structures. Any glandular organ may become affected with adenoma, and several varieties will be described hereafter in the chapters on the breast, thyroid body, prostate, testis, etc. The growth is usually slow, but it occasionally becomes very rapid.

Carcinoma.—The **malignant forms** of epithelial new growths are generally known as cancers or carcinomata, of which the following varieties may be described, viz., epithelioma, rodent ulcer, columnar carcinoma, and glandular or acinous cancer. The term colloid cancer is also used to indicate a degenerative change occurring in some forms of this class of tumours.

The essential character of a cancerous growth consists in an unlimited multiplication of the epithelial elements of the organ invaded. In some cases this may result in the formation of a superficial outgrowth of a papillomatous type (Fig. 39), while deep processes or columns of cells advance into the tissues along the lymphatic channels, and even burst through the basement membrane of glandular alveoli. The irritation of this development leads to an infiltration of the surrounding structures with round cells, which are presumably inflammatory in origin, by the agency of which the normal tissues are disintegrated and removed, and a fibro-cicatricial stroma of variable density developed around the epithelial outgrowths. Hence all cancerous tumours may be considered to consist of a fibro-cicatricial stroma (Fig. 43) within the alveoli of which are collections of epithelial cells, sometimes arranged in a methodical manner, but more frequently irregularly packed together, and with no intercellular substance between them. The alveolar spaces are in reality dilated lymphatics, and hence it is easy to understand that carcinomata are disseminated by way of the lymphatics; the cancer cells are always epithelial in origin, and of very variable size and shape. Bloodvessels ramify through the growth in the stroma, and are more or less abundant according to its density. Speaking generally, cancerous tumours are less vascular than sarcomata, although there is a greater amount of hyperæmia immediately around them. A considerable degree of pain, usually of a neuralgic type, is often complained of, owing to the implication of nerve filaments in the growth, and to their subsequent destruction. The tumours are, however, not necessarily tender to the touch.

Ætiology.—A vast amount of work has been undertaken with the object of determining the cause of cancer, although at present but little advance has been made. Formerly the disease was considered to be of **constitutional** origin, resulting from some morbid condition of the blood, and in favour of this fact the immense difficulty of eradicating it was educed, as also its hereditary nature in many cases. On the whole, however, this theory has been discarded in favour of one which maintains that it is primarily **local** in origin, and probably the result of the inoculation and development of some specific organism. The chief arguments in favour of its local origin are as follows: (1) That it often occurs in individuals who, up to the time of its onset, have been in perfect health; (2) that cachectic symptoms generally only manifest themselves in the later stages of the disease, being then readily explicable by excessive pain, the absorption of septic discharges, loss of blood, or possibly the toxic effect of some material absorbed from the growth; (3) that the original neoplasm is always single, multiple tumours being the result of infection from the primary growth; (4) that some definite focus of local irritation may frequently be traced as the cause of the tumour—*e.g.*, the irritation of the lip by a short clay pipe, the presence of ulceration or cicatrices of the tongue, resulting from ragged teeth or syphilitic affections, etc. It is also interesting to note that cancer usually involves the intestinal canal in situations where there is a sudden change of calibre, giving rise to increased friction from the passage of the contents—*e.g.*, at the upper and lower ends of the œsophagus, the pylorus, the ileo-cæcal valve, either end of the sigmoid flexure, the lower end of the rectum and the anus. (5) Moreover, if an early and thorough operation is undertaken, the growth can be completely eradicated from the system, whilst even if it recurs, it tends rather to attack the cicatrix or the neighbouring glands, indicating that the removal has been incomplete.

The infective nature of cancer is still *sub judice*. *Clinical* evidence exists to indicate that cancer may be transmitted from one person to another, but it is somewhat scanty in amount. Thus, cancer of the cervix uteri has been known to be followed by epithelioma of the penis in the husband. Again, it has been shown by Shattock that in certain houses (called by him 'cancer houses') one set of indwellers after another has been attacked by this disease. *Experimental* research, as to the transmissibility of cancer from one individual to another, is necessarily unobtainable, although it has been proved that, in a person already suffering from cancer, a portion of the growth transplanted to a distant part of the body will grow, and lead to the formation of a similar tumour at the site of inoculation. Attempts have also been made to transmit the disease to animals, but with a very slight degree of success, even in cases where the point of inoculation has been previously irritated. Hence the view that cancer is due to infection depends rather on the analogy of the disease to other chronic infective disorders than on any well ascertained facts. The relation of cancer to **Psorospermiæ** has been much discussed of recent years, and by some authorities the disease is supposed to be due to these organisms. Their opinions are based on the following facts: (*a*) That in the majority of cancerous growths certain abnormal bodies resembling the coccidia of psorosperms have been demonstrated within the epithelial cells; but even if these 'cancer bodies' are of this nature, it has yet to be proved that they are causative, and not concurrent manifestations, whilst it is also true that similar bodies can be shown to exist in sarcoma, tubercle, and even syphilis. (*b*) In rabbits suffering from undoubted psorospermosis, outgrowths somewhat similar in nature to epithelioma have been detected in the biliary ducts of the liver and other viscera, and these growths have even been produced by artificial inoculation with the organisms. (*c*) Cancer of the breast frequently follows Paget's disease of the nipple, in which latter disease psorosperms are almost always to be found. Much stronger evidence must, however, be produced before the theory can be accepted.

Epithelioma (*syn.:* **Squamous Epithelioma, Epithelial Cancer**).—By this term is meant a cancerous tumour growing from skin or mucous membrane. Formerly a variety known as columnar epithelioma was described, but this is really of glandular origin, and will be dealt with later on.

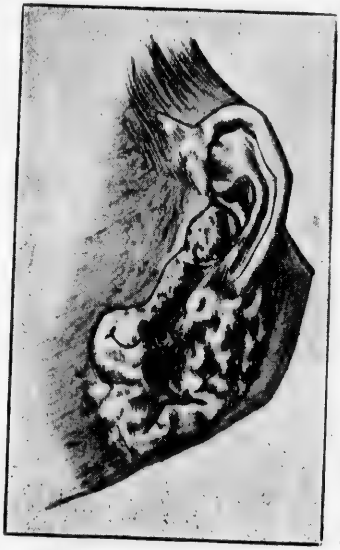

FIG. 38.—TYPICAL EPITHELIOMATOUS ULCER, SHOWING HEAPED-UP MARGINS AND DEEP CENTRAL CRATERIFORM EXCAVATION. (COLLEGE OF SURGEONS' MUSEUM.)

Epitheliomata are usually met with in middle-aged or elderly individuals, although occasionally they may be seen in young adult life. Any portion of the skin may become the site of this tumour, as also the mucous membrane of the mouth, pharynx, and œsophagus, and that lining the genito-urinary tract. It commonly results from some long-continued irritation, as in the lip or tongue, whilst epithelioma of the penis is always associated with a long foreskin. Old scars, especially if they break down and become ulcerated, are likely to be invaded, and the disease may supervene on intractable lupus.

Clinically, it may be looked on as a malignant wart, which tends not only to grow outwards from the surface, but also to burrow deeply into adjacent tissues; sooner or later ulceration follows. Several characteristic forms may be described: (*a*) It may occur as a nodular indurated mass, with hard everted edges and central ulceration, giving rise to a somewhat crateriform ulcer (Fig. 38). (*b*) The destructive process may extend equally with the new formation, leading to the appearance of a depressed ulcer, with sharply-cut edges, closely resembling a rodent ulcer. (*c*) Occasionally the superficial outgrowth may be very excessive, and the destructive process minimal, giving rise to a projecting cauliflower-like mass (*malignant papilloma*, Fig. 39). (*d*) A chronic epithelioma is sometimes seen, in which the fibrous stroma contracts and compresses the columns of epithelial cells; the surface is then indurated and wart-like, with but little ulceration, whilst the base is very hard, and the progress of the case much less rapid than in other forms (Fig. 227).

The disease, as a rule, early infects neighbouring lymphatic glands, which become the seat of a similar growth, and tend sooner or later to involve the skin and give rise to characteristic ulceration. As the disease progresses, more distant groups of lymphatic glands are attacked; it is unusual to find this form of cancer disseminated through the internal viscera, but it does occur. Occasionally the glands become cystic, especially in the neck, and on cutting into them a thin turbid fluid like sero-pus may escape, mixed, perhaps, with masses of epithelial débris; from time to time similar material is discharged from the resulting sinuses. Ulceration into the main vessels of the neck may also follow, and lead to death from hæmorrhage; otherwise the fatal event is due to cachexia and exhaustion.

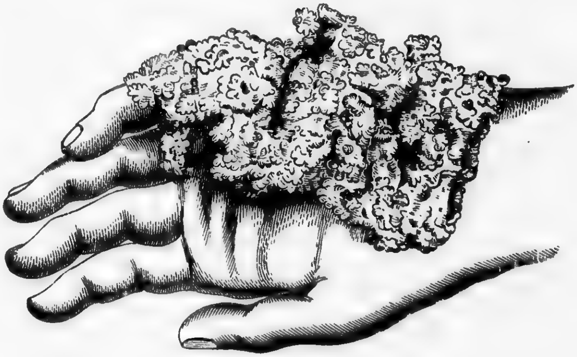

FIG. 39.—PAPILLOMATOUS TYPE OF EPITHELIOMA.

Microscopically, an epithelioma consists of club-shaped columns of epithelial cells, ramifying in the subcutaneous tissues, and interlacing freely with each other, so as to produce an irregular network, the meshes of which are occupied by a fibro-cellular growth (Fig. 40). The superficial cells in epithelioma are usually squamous in type, but in the deeper parts prickle cells are not unfrequently observed, whilst the processes are bounded by a tolerably definite layer of cuboidal epithelium, tending to become columnar. Within the processes, concentrically arranged collections of squamous cells are frequently observed, known as 'epithelial nests' (Fig. 40, *i*). The stroma in the neighbourhood of the advancing columns is always infiltrated with an abundant exudation of leucocytes.

The characters and treatment of epithelioma as met with in various regions of the body are dealt with under the appropriate headings.

Rodent Ulcer is generally admitted to be a cancerous tumour of an epitheliomatous type, commencing probably in the sebaceous glands. It is usually met with in elderly patients, though occasionally observed in those under forty, and is seen with special frequency on the upper two-thirds of the face, the skin below the inner and outer canthi being the chief seats of election (Fig. 41). It commences as a papule or flat-topped nodule in the skin, surrounded, perhaps, by an area of hyperæmia, which gradually and slowly progresses. The infiltration extends in all directions, but the ulceration usually keeps pace with the new growth, and, indeed, frequently exceeds it. The ulcer has a smooth but somewhat depressed surface, is perhaps covered with granulations, and bounded by a slightly-raised, indurated, rolled-over edge. In the later stages one can often detect evidences of

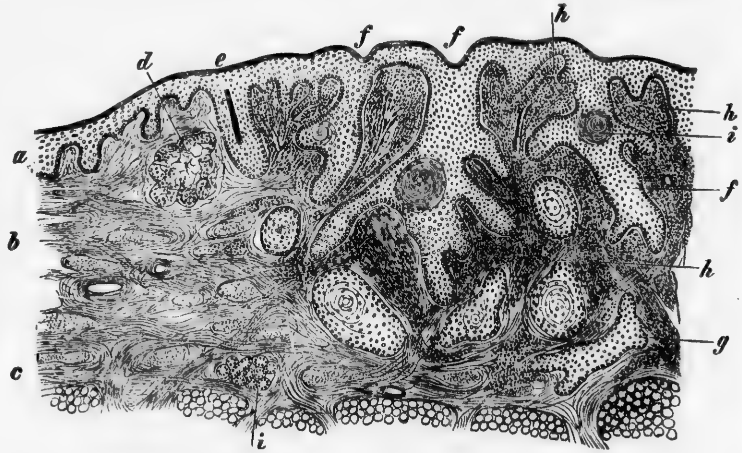

FIG. 40.—SECTION OF EPITHELIOMA. (ZIEGLER.)

a, Epidermis; *b*, corium; *c*, subcutaneous areolar tissue; *d*, sebaceous gland; *e*, hair follicle; *f*, cancerous ingrowths from the epidermis; *g*, deeply-set cancerous cell groups; *h*, proliferating fibrous tissue; *i* (above), cell nest or epidermic globe; *i* (below), sweat gland.

the new formation beneath the skin beyond the edge. If kept aseptic, there is but little discharge, and imperfect attempts at cicatrization are often observed, the scar, however, readily breaking down again; but where the surface is allowed to become septic, it is often covered with sloughs, and an abundant offensive discharge may result. The condition is painless; neighbouring lymphatics are not enlarged, and the general health does not suffer, except in the later stages. The progress of the case is slow, but continuous, and although it tends to spread superficially rather than deeply, sooner or later deeper structures become involved, and nothing hinders the destructive process, even the bones of the skull being cleanly eroded, and the dura mater exposed.

Microscopically, the growth is very similar to an epithelioma, from which, indeed, it may be difficult to distinguish it. Interlacing columns of epithelial cells, interspersed with fibrocellular tissue, are always evident, as in the latter disease, but the chief differences from epithelioma consist in the facts —(i.) that the constituent cells, although epithelial, are not epidermic in character, being smaller, more globular, never of the 'prickle-cell' type, and rarely showing signs of keratinization; hence 'cell nests' are uncommon, although a tendency to their formation is sometimes observed; (ii.) that the deep processes are not so distinctly columnar or club-shaped, tending to spread laterally beneath the unaffected skin rather than deeply; moreover, their outline is more clearly defined, and frequently angular on section; (iii.) that there is less cell infiltration around the new formation.

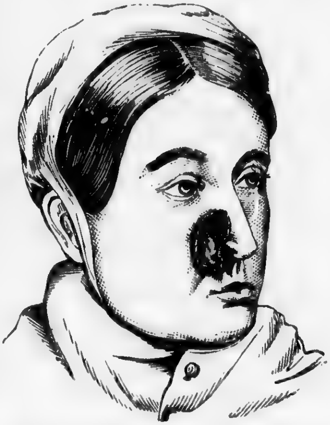

FIG. 41.—RODENT ULCER OF FACE.

A somewhat similar condition has been described by Mr. Hutchinson under the title *crateriform ulcer*, and probably consists of a chronic epithelioma, commencing in the sweat glands. It closely resembles rodent ulcer in its clinical features, and is practically benign.

The **Treatment** of rodent ulcer consists in excision when practicable, the defect being made good by granulation and skin-grafting, or by some plastic operation. Where such cannot be undertaken, the ulcer may be thoroughly scraped, and the surface treated with nitric acid or some similar caustic.

Columnar Carcinoma.—This affection, which was formerly termed 'columnar epithelioma,' is in the majority of cases a glandular cancer. It is met with most frequently in the alimentary canal, arising from any portion of it in which columnar epithelium occurs, and usually originating as an overgrowth of Lieberkuhn's follicles (Fig. 42). These grow outwards from the surface in the same way as a papilloma springs from the skin, but also penetrate deeply into the submucous and muscular coats. The deep processes retain an imperfect alveolar arrangement, the epithelial cells not penetrating beyond the basement membrane. A certain amount of fibro-cellular stroma is also found between them, and upon its amount the hardness of the tumour depends. In the firmer types the stroma is abundant, and fibro-cicatricial in quality, the growth of the tumour being slow; in the softer and more rapidly-growing forms the stroma is less abundant, and more of a simple fibro-cellular nature. On section of a limited portion of the growth, it would often be impossible to distinguish it from

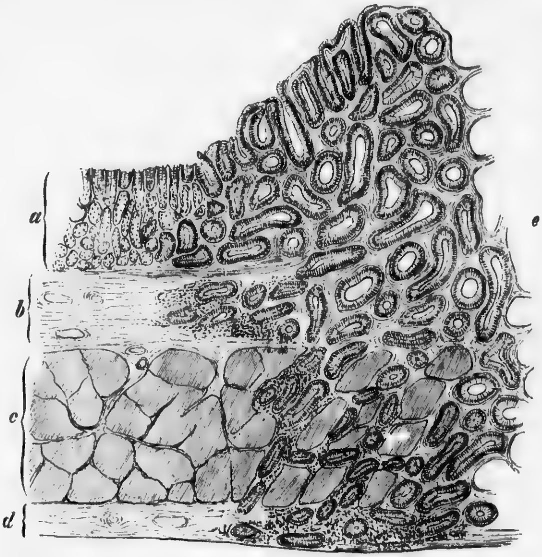

Fig. 42.—Section through Advancing Margin of Columnar Cancer of Stomach (×25). (Ziegler.)

a, Mucosa; *b*, submucosa; *c*, muscularis; *d*, serosa; *e*, neoplasm which, starting from the mucosa, has invaded the other layers. Small-celled infiltration has accompanied here and there the formation of the neoplastic tubules.

a simple adenoma of Lieberkuhn's follicles; but if a large section, including the whole thickness of the growth, is examined, the extension of the glands into and between the muscular fasciculi at once indicates the malignant nature of the case. Ulceration usually occurs, giving rise to a typical sore, bounded in the more chronic forms by indurated and everted edges. Neighbouring lymphatics are implicated, as in the case of all cancers, whilst later on the disease spreads to the viscera, and may be generally disseminated. A similar type of growth occurs in the cervical portion of the uterus, and occasionally arises in the ducts of secretory glands, such as the breast. It is also met with in the superior maxilla, originating in the tubular glands of the mucous membrane lining the antrum.

Glandular or Acinous Cancer.—Glandular cancer may be looked on as a malignant form of adenoma, bearing the same relation to it as does an epithelioma to a benign papilloma. The epithelium of the glandular acini, from which it originates, is not retained by the basement membrane, but travels beyond it along the lymphatics into surrounding parts, which are transformed by a process already described into the tumour substance. The amount of stroma varies considerably, and according to whether it is abundant or small in quantity, the tumour is hard or soft in consistence, and slow or rapid in growth. To the former type the term **Scirrhus** is applied; to the latter, **Encephaloid**. A third variety, known as **Colloid**, is really due to degenerative changes of a special nature.

Scirrhus is met with most frequently in the breast, but also occurs in the prostate, pancreas, and pyloric end of the stomach. The clinical features of the disease as seen in the breast are described in the chapter on diseases of that organ. On naked-eye examination a scirrhous tumour appears as a hard nodular mass, the limits of which are imperfectly defined. When cut across, it creaks under the knife, and presents a yellowish-white surface, which rapidly becomes concave owing to the contraction of the fibrous stroma. It has often been compared to the section of an unripe pear or turnip, both on account of the grating sensation imparted to the knife, and from its appearance. On scraping the surface with the blade of a knife, a typical cancer juice is obtained, consisting of epithelial cells and débris.

On microscopical examination, the tumour is found to consist of an abundant and well-marked stroma (Fig. 43), the acini of which are filled with epithelial cells (Fig. 44). In the centre fatty degeneration is often present, small cysts being occasionally produced in this way. At the periphery the growth may be seen extending in all directions along the lymphatics, whilst a round-celled infiltration of the surrounding tissues is also evident.

The relative amount of stroma and cells varies considerably in different specimens. Where the former is very excessive, the cell elements, and, indeed, the whole tumour, may undergo atrophy, constituting the variety known as 'atrophic scirrhus.' On the other hand, many cases occur in which the epithelial cells are much more abundant, and then it may be impossible to state to which of the artificially-constituted groups of glandular cancer it belongs.

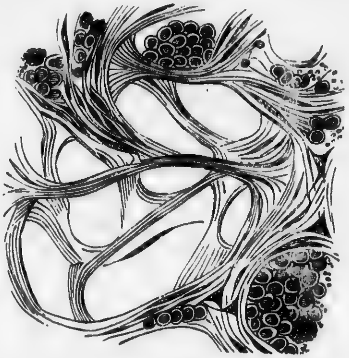

FIG. 43.—STROMA OF SCIRRHUS, FROM WHICH THE CELLS HAVE BEEN TO A LARGE EXTENT REMOVED.

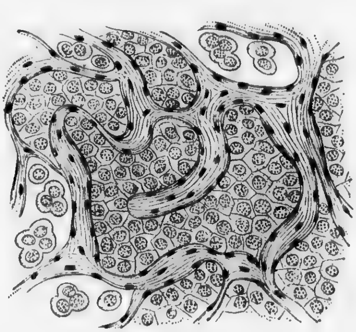

FIG. 44.—SECTION OF GLANDULAR CANCER, SHOWING ALVEOLI FILLED WITH EPITHELIAL CELLS, AND A NOT VERY ABUNDANT STROMA. (TILLMANNS.)

Such a growth would not be very hard.

Encephaloid or **Medullary Cancer** is the term given to a growth of a similar nature, in which the stroma is much less abundant than the cell elements. It constitutes a soft, rapidly growing tumour abundantly supplied with bloodvessels, and tending very early to affect neighbouring lymphatic glands. The skin over such a tumour is stretched, with dilated blue veins coursing over it. Ulceration occurs early, and from this surface a foul, bleeding, fungating mass sprouts up, constituting the condition formerly known as a 'fungus hæmatodes.' Encephaloid cancer is met with in the breast, testis, kidney, and a few other glandular organs.

On section it is found to be composed of a soft whitish mass, somewhat resembling brain substance. It is usually very vascular, perhaps pulsating, and hæmorrhagic extravasation into its tissues is not uncommon. An abundant juice is obtained on scraping it. Under the microscope, it is seen to be composed of large groups of spheroidal epithelial cells, held together by a scanty fibro-cellular stroma.

Colloid Cancer results from a degeneration of the epithelial cells of a glandular cancer. Its most frequent site is within the abdominal cavity, in connection with cancers arising from the stomach, intestine, or omentum.

To the naked eye colloid cancer presents an alveolar structure, the spaces being filled with translucent gelatinous material of varying density. Microscopically, the epithelial cells are rarely distinguishable, being replaced by a structureless colloidal substance. Towards the periphery, however, the cells may be seen in process of degeneration, globules of the material forming within them and pressing the nucleus to one side.

The **Treatment of Cancer** always consists in its removal by operation when practicable. If such is conducted in a thorough manner and at a sufficiently early date, a good result may be anticipated; but, owing to the tendency of all cancers to spread along the lymphatics, its eradication is a matter of the greatest difficulty. Recurrence is therefore very liable to ensue.

In all cases where removal of the disease by the knife is impracticable, owing to its extent, it may sometimes be possible to remove a portion of the disease, the remainder being dealt with by caustics. Of these the most satisfactory is chloride of zinc, which is usually applied as a paste, a little opium being added to allay pain. In other cases it has been proposed to starve the growth by tying the chief nutrient artery, and to diminish pain by division of sensory nerves; such can, however, only give the most temporary relief.

Of recent years other methods have been suggested for the treatment of inoperable malignant disease—*e.g.*, the interstitial injection of pyoktanin or methyl violet, or of various bacterial products, such as Coley's fluid. Sufficient evidence is not yet forthcoming to determine the practical value of these proceedings, but there is no doubt that sarcomata are more readily influenced than cancers.

In hopeless cases, all that can be done is to keep any ulcerated surface free from irritation, and if possible aseptic, whilst the general health is maintained by suitable diet and drugs, and excessive pain is kept in check by the administration of opium or morphia.

Cysts.

By a cyst is usually meant a more or less rounded cavity, with a distinct lining membrane, distended with some fluid or semi-solid material. The term is used somewhat loosely, being applied to a variety of manifestations which it is extremely difficult to classify, owing to the fact that conditions which are pathologically similar in origin are sometimes termed cysts in one part of the body, and not so in another. For practical purposes, however, they may be grouped as follows:

I. Cysts of *embryonic origin*, or arising in connection with embryonic remains.

II. Cysts arising from the *distension of pre-existing spaces* (distension cysts).

III. Cysts of *new formation*.

IV. Cysts of *degeneration*.

I. Cysts of Embryonic Origin, or arising in connection with Embryonic Remains.

1. The most important cysts to be considered under this heading are those known as **Dermoids**. These are characterized by the existence in normal situations of cavities lined with epithelium, from which may be developed any form of cutaneous appendage —*e.g.*, hairs, nails, teeth, etc.—whilst the space is usually occupied by sebaceous or mucous contents. The structure of the lining wall is very similar in nature to skin or mucous membrane, consisting of stratified epithelium, from which a considerable growth of sebaceous glands and hair follicles often takes place.

Several varieties of dermoids are described:

(*a*) **Sequestration Dermoids** are cysts arising from the incomplete disappearance of surface epithelium in situations where, during embryonic life, fleshy segments coalesce. Thus, in almost any part of the middle line of the body such tumours may develop, owing to the fact that there is here a union of two lateral segments. Similarly, they are not uncommon about the face and neck, occurring along the lines of the facial and branchial clefts. Perhaps the most common position for them in this region is the upper portion of the orbito-nasal cleft, behind and to the outer side of the eye (Fig. 45). It is not unusual to find the skull defective beneath them, and a pedicle extending from the deep side, connecting them to the dura mater. Sequestration dermoids appear as round, definitely limited tumours, over which the skin glides freely, but are usually somewhat adherent to the deeper parts. They are firm and elastic to the touch, and filled with sebaceous material, containing fatty débris, flattened epithelial cells, perhaps hairs, and occasionally teeth. As a rule, this form of dermoid may be removed without difficulty, but in those occurring about the scalp, with the bone hollowed out behind them, it is perhaps advisable to delay operation till adult life, unless the tumours show any tendency to rapidly increase in size. The reason for this is that the bone gradually grows up around the deep pedicle, and thus closes the communication with the cranial cavity. In some cases it may be difficult to remove the whole of the lining membrane by dissection, and under these circumstances the surgeon must attempt to destroy the portion left behind with the cautery or caustics, otherwise recurrence is almost certain to follow.

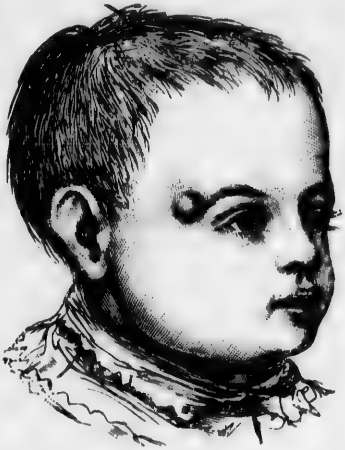

FIG. 45.—DERMOID CYST, GROWING AT THE OUTER ANGLE OF THE ORBIT. (BLAND SUTTON.)

(*b*) Dermoids may also arise in connection with embryonic canals and passages, and have then been called **Tubulo-Dermoids**. These are chiefly met with in connection with the thyro-glossal duct (Chapter XXVI.) and the post-anal gut (Chapter XXIX.).

(*c*) **Ovarian Dermoids** are usually unilocular, and of large size. As a rule, they are lined with skin, from which an abundant development of cutaneous appendages is often observed. Thus, the cavity may be more or less filled with hair, which is very similar to that found on the surface of the body, and is stated to become white with age, or may even be shed at the same time as the scalp becomes bald. Large masses of teeth set in bony alveoli are also seen in this situation, and even nipples and mammæ have been developed.

2. **Cysts** occasionally arise *in connection with* the formation of *the teeth;* such have been already alluded to under the terms follicular and epithelial odontomes (p. 152), the former being also known as dentigerous cysts, the latter as fibro-cystic disease of the jaw.

3. Various cysts also develop in connection with *the remains of the Wolffian body*, as also from *its tubules and duct*.

In the **male** (Fig. 46), the Wolffian body atrophies almost completely, being represented by a few blind tubules, situated close to the epididymis, and known as the paradidymis, or organ of Giraldés. Fibro-cystic disease of the testis (adenoma testis) is said to arise from this structure. The majority of the ducts of the Wolffian body form the vasa efferentia testis; a few of the upper ones, however, contract no attachment to the testis, and their free ends (known as Kobelt's tubes) may become dilated, and form small cysts, situated close to the hydatid of Morgagni. It is possible that an encysted hydrocele of the epididymis sometimes arises from one of these unobliterated tubules. The duct of the Wolffian body forms the lower portion of the epididymis and vas deferens.

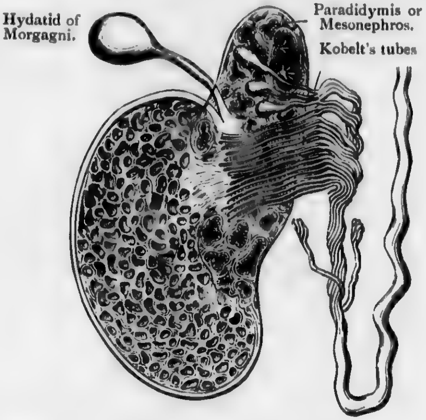

Fig. 46.—Diagram of Adult Testicle, to show Relation of Mesonephros and its Ducts. (Bland Sutton.)

In the **female** (Fig. 47), the remains of the Wolffian body are sometimes met with as a series of closed tubes in the neighbourhood of the ovary (paroöphoron). Cysts may arise in connection with this structure, and are chiefly characterized by their inner walls being the seat of proliferating papillomata. The Wolffian tubules can almost always be recognised in the broad ligament, constituting the parovarium, or organ of Rosenmüller. **Parovarian Cysts** formed from the distension of this structure are usually unilocular, and filled with a clear limpid serous fluid; they have no definite pedicle, and strip up the layers of the broad ligament. The Wolffian duct generally atrophies, but occasionally runs down between the layers of the broad ligament close to the uterus, to open in the vagina near the urethral orifice, being then known as Gärtner's duct. Cysts may arise in connection with this structure, projecting into the lateral fornix of the vagina; they are, however, extremely rare.

4. The *processus vaginalis*, or funicular process, is the term applied to the protrusion of peritoneum which precedes the testis to form the tunica vaginalis, and which in the female accompanies the round ligament. Normally it becomes obliterated, but occasionally portions of it remain patent, and are distended with a clear straw-coloured serous fluid, constituting in the male an *encysted hydrocele of the cord*, and in the female a *hydrocele of the round ligament*.

II. Cysts due to the Distension of Pre-existing Spaces.

(*a*) **Exudation Cysts** arise from the distension of cavities which are unprovided with excretory ducts, and are frequently of an inflammatory nature. Such spaces may be lined with epithelium or endothelium. As illustrations of *epithelial* cysts may be mentioned those which arise in connection with the thyroid body, as also conditions due to the distension of the central canal of the nervous system (syringomyelia or syringo-myelocele), and those forms of ovarian cysts which arise from distension of Graafian follicles.

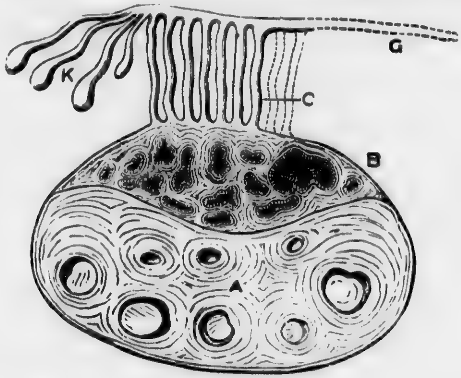

FIG. 47.—DIAGRAM TO REPRESENT THE CYST REGIONS OF THE OVARY. (BLAND SUTTON.)

A, Oöphoron, or ovarian tissue proper; B, paroöphoron, or tissue of the hilum; C, parovarium; K, Kobelt's tubes; G, Gärtner's duct=main Wolffian duct.

Exudation cysts lined by a serous or *endothelial* wall are much more numerous than the former. Enlargements of bursæ, hydroceles of the tunica vaginalis, funicular process, or canal of Nuck, and some forms of ganglia, are of this nature. Diverticula or hernial protrusions of the synovial membrane also occur, and are known as Baker's cysts.

A **Serous Cyst** is supposed to arise from the distension of lymph spaces, giving rise to uni- or multi-locular cavities, lined with endothelium, and containing a limpid straw-coloured fluid. Such a growth when met with in children, either in the neck or elsewhere, is usually called a *cystic hygroma;* a somewhat similar condition is also found in the breast.

(*b*) When a collection of blood forms in a pre-existing cavity, a so-called **Cyst of Extravasation** is produced. Such is met with in the pelvis or tunica vaginalis (hæmatocele), and also occasionally on the surface of the brain, constituting there the condition known as an arachnoid cyst.

(*c*) **Retention Cysts** always arise from obstruction to the escape of some natural secretion from a gland duct or tubule. The cavity thus formed is lined with epithelium, whilst, owing to the irritation produced by the tension, a fibro-cicatricial wall of variable thickness is developed outside. There is often a considerable tendency to the formation of intracystic growths, especially in the breast, whilst the contents generally consist of the inspissated secretion, perhaps mixed with blood.

Retention cysts may develop in connection with any ordinary glandular tissue. The majority are described under the appropriate headings, viz., Mammary Cysts, Renal Cysts, Ranula, Pancreatic Cyst. Here we need only refer to mucous and sebaceous cysts.

Sebaceous Cysts occur on any part of the surface of the body, but especially the scalp, and are due to obstruction of the duct of a sebaceous gland. They present in the shape of rounded swellings, firm and elastic to the touch, moveable on the deeper structures, and always attached at one spot to the skin. On careful examination, the obstructed mouth of a sebaceous follicle can usually be seen, and possibly some of the contents of the sac squeezed through this opening. The cyst wall is formed by several layers of epithelium, surrounded by dense fibro-cicatricial tissue, and if exposed to irritation or pressure, as when situated on the back or shoulder, and rubbed by the braces, it may become very firmly adherent to the surrounding parts. The material contained within is of a cheesy, pultaceous consistency, yellowish-white in colour, and under the microscope is seen to be composed of fatty and granular débris, epithelial cells, and cholesterine. Sometimes a distinctly adenomatous element is present, so that the cyst walls are thick and firm. Left to themselves, they may attain considerable dimensions, the walls even becoming calcified. Occasionally the exudation oozes through the duct, and dries on the surface; layer after layer of this desiccated material collects, finally giving rise to what is known as a **Sebaceous Horn**. These become dark in colour from admixture with dirt, and always more or less fibrillated in texture, whilst the base is infiltrated and hyperæmic. Sebaceous cysts sometimes inflame and suppurate. When the skin has given way over them, the contents are only partly discharged, and the remainder undergoes putrefactive changes, giving rise to a horribly offensive ulcerated surface, which may readily be mistaken for epithelioma, and spreads rapidly. True malignant disease of an epitheliomatous nature is sometimes said to occur.

Diagnosis.—From a *dermoid cyst* it is known by the fact that the dermoid arises early in life, and is sometimes congenital, whilst it is hardly ever directly attached to the skin. From a *fatty tumour* it is recognised by the absence of lobulation, and by its more solid character, whilst a lipoma is softer and more moveable. From a *chronic abscess* it is distinguished by the existence of the dilated orifice, by its firmer consistency, and by the history.

Treatment.—A sebaceous cyst should be entirely and completely removed if giving rise to any inconvenience or trouble. In the scalp all that is needed is to transfix the tumour, squeeze out the cheesy contents, and then the cyst wall can be readily removed by grasping it with dissecting forceps and pulling it away. In other situations the cyst wall may need to be dissected out; but even then it is advisable to open it by transfixion, and to deal with the sac from below rather than from above. Horns and fungating ulcers should be excised with the surrounding skin.

Mucous Cysts arise in connection with the glandular follicles found in mucous membranes, much in the same way as sebaceous cysts originate in the skin. They are often due to injury, and are rarely of great size, consisting of thin-walled cavities distended with mucus; they are elastic to the touch, and usually translucent, and are most often seen on the lips, beneath the tongue, or sometimes on the labia vulvæ or os uteri. All that is needed in the shape of treatment is to open and excise them.

III. **Cysts of New Formation** are such as occur apart from any embryonic condition or pre-existing cavity. The following varieties may be described:

(*a*) An **Implantation Cyst** is one which arises from the accidental intrusion into the subcutaneous or submucous tissues of epithelial cells which retain their vitality, and are enabled to develop a cyst very similar in nature to a dermoid; in fact, it may be looked on as an *Acquired* or *Traumatic Dermoid*. Such an occurrence is usually brought about as the result of an injury, especially from punctured wounds; thus, cysts of this nature have been met with in the fingers or palm of the hand as a consequence of the penetration of some sharp instrument, whilst they are also occasionally seen in the anterior chamber of the eye, following an iridectomy. They are, moreover, observed in the axillæ of cattle, as a result of goading them with some sharp implement. The clinical signs and treatment are similar to those of a dermoid cyst.

(*b*) **Cysts** sometimes form **around foreign bodies**, which thus become encapsuled. They are lined either by granulation tissue or endothelium, surrounded by a variable amount of fibro-cicatricial tissue.

(*c*) **Blood Cysts** are sometimes of doubtful origin. Some of them certainly arise from extravasation of blood, and in such cases coagulated blood, or a thin serous fluid, is found within, the cavity being perhaps lined with laminated fibrin. In many cases a so-called blood cyst really consists of a soft sarcoma, into which hæmorrhage has occurred; but in addition to these, a few instances are on record in which a thin-walled cavity existed, occupied by blood, and readily refilling after the cavity had been tapped. Such conditions have been most frequently observed in the neck (see Chapter XXIX.).

(*d*) **Parasitic Cysts** are produced by the irritation caused by the growth within the tissues of certain living organisms. Thus, in the disease known as trichinosis, derived from eating unsound pork, the *Trichina spiralis*, a small round worm, develops in large numbers in the voluntary muscles, and becomes surrounded by a capsule which is subsequently calcified.

The most important of these parasitic cysts is that arising from the development within the body of the scolex stage of the *Tænia echinococcus*, giving rise to what are known as **Hydatid Cysts.** This disease is infinitely more common in Australia than in this country. The *Tænia echinococcus* (Fig. 48) is a minute tapeworm, less than half an inch in length, which inhabits the intestinal canal of dogs; it consists of four segments, the posterior one larger than the rest of the body, and containing the genital organs. When mature, this last segment becomes filled with ova, which are discharged, and these find their way into the human stomach by the media of water or uncooked vegetables, such as watercress, which have been contaminated with the dog's excreta. The process of digestion sets the embryo free, and by means of a crown of little hooks which it possesses, as well as four suckers, it is enabled to bore its way through the walls of the stomach, and thence travels by the bloodvessels, as a parasitic embolus, either to the liver or to any other part of the body. As a result of the irritation caused by its presence, a sac forms which originally consists of three layers: externally, a fibro-cicatricial layer, then an intermediate lamellated layer of chitinous material, and finally the cyst is lined by a protoplasmic germinal layer, from which solitary tænia heads or scolices, also provided with four

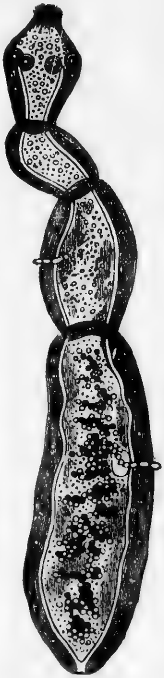

FIG. 48.—TÆNIA ECHINOCOCCUS (× ABOUT 20).

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suckers and a circlet of hooks, may be developed, whilst sometimes groups of them, known as brood-capsules, may arise in the same way (Fig. 50). Daughter-cysts are not unfrequently formed

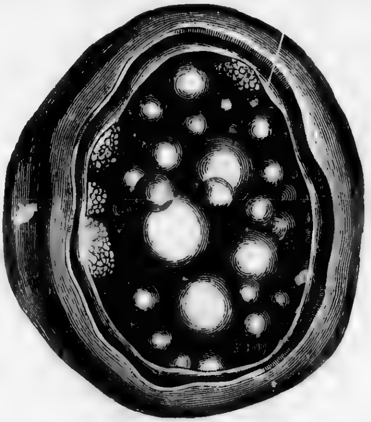


FIG. 49.—HYDATID CYST (DIAGRAMMATIC), SHOWING DAUGHTER-CYSTS AND BROOD-CAPSULES GROWING FROM THE WALLS. (AFTER BLAND SUTTON.)

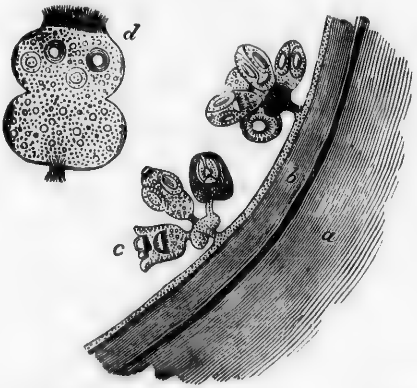


FIG. 50.—DIAGRAMMATIC SECTION OF WALL OF CYST.

a, Fibro-cellular capsule, here somewhat exaggerated; *b*, lamellated chitinous layer, or ectocyst; *c*, brood-capsules developing from the protoplasmic layer, or endocyst; *d*, scolex, or separate head, enlarged.

from the scolices, and they in their turn may pass through the same changes, although as a rule they are barren. Occasionally even the main cyst may be sterile (acephalocyst), and in such cases the walls become very definitely laminated. The fluid contained in the cyst varies much in amount, but is always of low specific gravity, not more than 1007; it is colourless, but slightly opalescent, limpid, and contains but a trace of albumin, although a considerable amount of chloride of sodium is present. On examining the fluid microscopically, the characteristic hooklets are observed. The organs usually affected by hydatid disease are the liver, kidneys, and brain, but any part of the body may be attacked. Occasionally in the liver, and usually in bone, multiple cysts develop quite distinct from each other, and with no enveloping cyst-wall.

For the diagnosis and treatment of hydatid cyst of the liver, see Chapter XXX.

In other regions, if the tumour cannot be removed by dissection, reliance must be placed on aspiration, where the situation of the growth renders this practicable.

IV. **Cysts of Degeneration** arise in connection with tumours, especially those where the blood-supply is not very abundant. Thus, mucoid degeneration is not uncommon in fibromata, fibromyomata, chondromata, and even in the harder forms of cancer. Occasionally cysts form in the sarcomata from this cause, but more frequently as a result of hæmorrhage.

CHAPTER VII.

WOUNDS.

A WOUND has been defined as the forcible solution of continuity of any of the tissues of the body; but the term is more commonly limited to injuries of the soft parts, involving the skin or mucous membranes. Lesions in which the skin does not participate, and in which the deeper structures, such as bones, ligaments, etc., are not involved, are more frequently spoken of as contusions.

A **Contusion** is any subcutaneous wound or injury due to the agency of external violence, causing laceration of the cellular tissue, without necessarily involving such deeper structures as muscles, tendons, nerves or bones. If, however, these are injured, special features may be added to the condition beyond those of a contusion. The signs of this latter lesion are usually very obvious, viz., **pain, bruising**, or discoloration of the part, and **swelling**. These are readily explained by the injury inflicted on the subcutaneous tissues, which in the worst cases may be entirely disorganized and separated from the skin. The amount of bruising varies with the part injured and the severity of the lesion; thus, in the eyelids, scrotum, and vulva, where the tissues are lax, the ecchymosis will be very extensive and of a black colour; on the scalp there is, on the other hand, but little swelling, if the injury does not include bleeding beneath the aponeurosis of the occipito-frontalis. Again, the condition of the patient's general health influences the amount of blood effused; in a strong man in good training, but little bruising is ever seen, whilst in those of a languid temperament and relaxed tissues, the slightest injury often suffices to produce a very conspicuous ecchymosis. Blebs and bullæ may form over the injured spot in bad cases. The changes that occur in a bruise are well known, the colour passing from a blackish-purple through various shades of brown and green to a yellow, which gradually fades and disappears; this is due to the disintegration of the red corpuscles, and staining of the tissues by the hæmoglobin thus set free, or by the products formed during its removal. When hæmorrhage has taken place into the deeper parts or under dense fasciæ, it is often some days before the bruise 'comes out,' and this may occur at some distant spot, *e.g.*, in the eyelids after a blow on the scalp, or, again, after a fracture of the neck of the humerus, the blood may travel along the muscular and fascial planes, and the bruise first appear about the elbow.

As a rule, in a bruise or ecchymosis, the tissues are merely infiltrated with blood, but occasionally the extravasation is more localized, collecting in a cavity formed by the laceration of the tissues, and remaining as a fluid swelling, or **Hæmatoma**. Such somewhat resembles an abscess to the touch, but differs from it in its history, having supervened immediately after an injury, and having appeared without any heat or other signs of inflammation; moreover, though at first fluid and soft, it soon tends to become harder, whereas an abscess is preceded by a stage of brawny infiltration, and the softening comes later. The subsequent history of a hæmatoma varies somewhat according to circumstances. (*a*) A deposit of fibrin may occur peripherally, leaving for a time a fluid centre, which gradually disappears, and the whole is finally absorbed. This is well exemplified in a sub-pericranial cephalhæmatoma, where the contrast between the fibrinous deposit without and the fluid centre is sometimes so accentuated as to give the impression of a depressed fracture. (*b*) The fluid portion of the blood may be absorbed almost entirely, and the solid fibrinous residuum may remain and become organized into a firm fibroid tumour which persists indefinitely; the mass is more or less laminated, and not unfrequently pigmented. (*c*) The fibrin may be entirely absorbed, and a slightly pigmented fibrous capsule formed containing serous fluid, and constituting a definite cyst. Such is best seen in connection with the cerebral tunics, and is there known as an arachnoid cyst. (*d*) Infection from within or from without may occur, leading to suppuration.

In forming an opinion as to the gravity of a subcutaneous injury, one must be guided by the part injured, the extent of tissue involved, the amount of blood extravasated, and the age and vitality of the individual. In the less severe cases, though there may be much manifestation of bruising, recovery will ensue, but under less favourable conditions sloughing and death of the injured tissues may result.

The **Treatment** of a bruise consists, as a rule, in the application of cold or evaporating lotions in order to check the bleeding, but such must be used with care in old weakly individuals or where much laceration of the tissues has taken place, for fear of the injured parts dying. The skin should never be incised except under special circumstances, such as the rupture of a large artery, or when some definite advantage is to be gained by dealing at once with the injured structures; for though under careful antisepsis the dread of opening recent collections of blood no longer exists, yet it should not be lightly undertaken. At the same time, when a tense and painful hæmatoma exists, as under the fascia lata of the thigh, recovery can be hastened and pain relieved by an aseptic puncture, followed by careful compression. In general bruising of the body from a fall or extensive injury, pain can often be relieved by applying hot fomentations or by a hot bath. Any subsequent inflammatory phenomena must be treated in accordance with general surgical principles. There is often a certain amount of fever and constitutional disturbance for a few days, and these must be dealt with by purgatives and a suitable limitation of diet.

Open Wounds.

An open wound may be defined as a solution of continuity of any superficial part of the body, including skin or mucous membrane. Various kinds of wounds are described, such as the incised, lacerated, contused, punctured, poisoned, and gunshot; but, of course, the most important distinction to draw is between the infected and the non-infected.

I. **Incised Wounds.**—An incised wound is one made by any sharp cutting instrument, such as a knife or sword, but occasionally a wound not produced in this manner may be characterized by similar appearances; *e.g.*, the skin of the knee or elbow may be cleanly split open from falling on it with the limb flexed, and occasionally a policeman's truncheon will lay open the scalp as evenly as if a knife had been employed, although the edges of the wound must of necessity be bruised.

The special features of an incised wound are as follows:

1. The hæmorrhage is free, from the fact that the vessels are cleanly divided. The amount, of course, depends on the size of the vessels involved, and the vascularity of the part; its continuance, upon the density of the structures, allowing or not of contraction and retraction of the severed ends. An incision through congested or inflamed parts is likely to bleed much more than usual.

2. Separation of the lips of the wound also occurs, but the amount of gaping depends upon the elasticity and character of the parts involved.

3. Bruising of the margins of the incision is absent, so that under ordinary circumstances rapid healing (by first intention) should obtain. The surfaces, to begin with, are lined by a microscopic layer of damaged tissue, some of which may be actually dead; but if suitable precautions are taken, this is all absorbed, and will in no way interfere with satisfactory union.

Treatment of Incised Wounds. — Seven essentials must be attended to if primary healing is to be obtained, viz.:

(i.) **The Arrest of all Bleeding.**—If there is general oozing, exposure to the air is often quite sufficient; or sometimes it may be supplemented by pressure for a few minutes with an aseptic sponge. Arteries and veins will need a ligature, but if situated close to the skin, they may often be secured by passing the needle used for inserting the suture under the bleeding spot.

(ii.) **The Removal of Foreign Bodies, and Cleansing of the Wound and its Surroundings.**—Dirt, splinters of wood or glass, fragments of cloth, etc., must all be most carefully taken away, and it may be necessary to anæsthetize the patient and enlarge the wound for this purpose. Irrigation with a 1 in 40 carbolic lotion is often sufficient in many cases to render it aseptic; strong antiseptics often do more harm than good by irritating the tissues and increasing exudation.

(iii.) **The coaptation of the opposed surfaces** by means of **sutures** may now be attended to, when there is a dry and presumably aseptic wound. Many substances have been, and are, employed for this purpose, but amongst the best are fine silver wire, silk, horsehair, silkworm gut and catgut. In casualty work, and for parts of the body where but little scar is subsequently desirable, as in the face, horsehair and silkworm gut, being non-absorbent, are perhaps the best materials to employ; but in ordinary operative work, which will be more certainly aseptic, and where the after-treatment is more efficient, fine catgut or silk may be used. There are three chief varieties of sutures, viz., the buried, the deep, and the superficial.

Buried sutures are employed a good deal in the present day, since there is no danger associated with inserting a foreign body into the tissues, if both it and the wound are aseptic. Catgut or silk are the agents made use of, and nerves, tendons, muscles or fasciæ are the structures mainly dealt with. In deep wounds it is always most desirable to effect union in this way of all the parts divided (that is, to build the part up again), and not merely to unite the skin over them.

Deep stitches, or *sutures of relaxation*, are required in cases where there is some difficulty in bringing the edges of the wound together, in order to transfer the tension from the healing margin to tissues further away, the edges being thereby relaxed. For this purpose thick silver wire may be employed, inserted 1 or 1½ inches from the margins, and tied directly, or lead buttons may be interposed next to the skin, and the ends of the wire fastened round the projecting edges, thus diffusing the pressure over a greater space.

Superficial stitches, or *sutures of coaptation*, must be so inserted as to bring the edges of the wound into contact without undue pressure, and without any folding in of the skin. Various methods are employed in the application of these, viz.: 1. The *interrupted suture* (Fig. 51, A), in which each stitch is separately finished off, the knot lying well to one side of the incision. This is very frequently employed, and is usually most satisfactory, especially in wounds which are of irregular shape or in which there is any tension. 2. The *glover's stitch* (Fig. 51, B) is a continuous one, in which the thread is carried on from point to point, and only fastened at the ends; it is not a form to be recommended for general use.

3. The *blanket* or *buttonhole stitch* (Fig. 51, C) is a form of continuous suture which has been adopted for several years, and is one of the best which can be employed for extensive wounds or incisions. In it the needle, after traversing the lips of the wound, is carried under the slack of the thread, so that the loop of each stitch, as it is tightened, is maintained at right angles to the edge of the wound, whilst the intermediate portion lies parallel to it. To fasten it off, the needle is passed in the opposite direction through the edges of the incision, with the free end long enough to prevent it coming through, and so enable it to be tied to the double portion carrying the needle. 4. The *quilled suture* is not often employed. It consists in tying the stitches round a quill or portion of catheter on either side of the wound, so that the deep surfaces may be maintained in apposition, whilst the superficial portions are left clear for additional sutures. Probably the only conditions under which it is now used are in the operations for ruptured perineum, or for extensive perineal or urethral fistulæ. 5. The *twisted* or *figure-of-8 suture* is occasionally made use of for

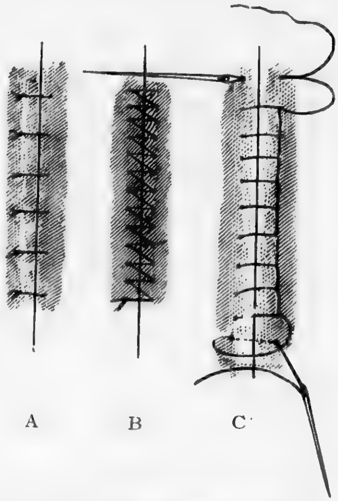


FIG. 51.—VARIOUS FORMS OF SUTURE.

A, Interrupted suture; B, continuous suture; C, blanket stitch. At the lower end the needle has just been passed, and the way in which it catches up the loop is indicated. At the upper end the method of finishing off is shown: viz., the needle is passed in the opposite direction to all the other stitches, the free end being left long, so as to enable it to be tied into a knot with the double thread which the needle has carried through.

harelip or scalp wounds, but it has many disadvantages. A pin or needle is passed through the sides of the wound, which are brought into apposition with the fingers, and maintained by twisting silk around either end of the needle in a figure-of-8 fashion.

Plasters are sometimes used instead of sutures, but the wounds must be very small and insignificant which only require such treatment. A fine aseptic suture is in most cases preferable.

(iv.) **Drainage** must, if necessary, be provided for, in order to guard against the irritation and tension of retained blood or exudations. There is still much difference of opinion as to the need of drainage-tubes, and individual proclivities must decide as to the practice to be adopted in particular cases. In wounds where there is any doubt as to the completeness of the hæmostasis, or where there has been much tearing or laceration of the tissues, it is wise to insert a tube for twenty-four to forty-eight hours, in order to allow effused blood to escape; but if the wound is dry and aseptic, and efficient pressure can be exerted by the dressings, it may be advantageously dispensed with. An aseptic sponge inserted between the layers of the dressing will form a soft, elastic, and yet firm pad for exerting such pressure.

When, however, drainage is thought necessary, the indiarubber tube introduced by Chassaignac will be found to answer well; it should be cut off flush with the surface, and stitched to the edges of the wound so as to prevent it slipping in or out, and thus obviating the loop of silk usually attached to it. Decalcified bone tubes have been substituted for the above, but with no distinct advantage. For small wounds, a strand of horsehair or a strip of gauze or protective will generally be all the drainage requisite.

(v.) **All fresh sources of irritation and infection** of the wound must be excluded by some form of antiseptic or aseptic dressing; these will be described later (p. 201).

(vi.) **Rest** to the injured part must be secured by such an arrangement of splints, slings, or bandages, as may be necessary.

(vii.) The **general health** of the patient is a most important item to attend to. In an operation case the bowels are always to be previously opened, and the patient's diet carefully regulated; in casualty work a good purge should be administered as soon as convenient, and the food and drink limited.

The conditions which *prevent* healing of an incised wound by first intention are essentially the reverse of the seven requisites mentioned above, and may be epitomized thus: (i.) Non-arrest of the bleeding, causing separation of the lips or deeper portions of the wound; (ii.) the presence of foreign bodies, often impure, or other septic material; (iii.) the edges not being brought into contact; (iv.) imperfect drainage leading to tension upon the stitches; (v.) subsequent infection of the wound owing to a faulty dressing, etc.; (vi.) lack of rest to the part; and (vii.) constitutional conditions, such as deficient general vitality from disease or other causes, resulting in want of action in the wound.

Should any signs of inflammation show themselves in an incised wound, the probability is that they are septic in origin, and will be accompanied by some amount of fever. Union by first intention will rarely occur under such circumstances, and, indeed, it is better to take out some or all of the stitches at once, and thus relieve any tension which may be present. Occasionally an accumulation of blood or serum may occur in the deeper parts of the wound whilst the superficial parts are healing, necessitating a relief of tension by a partial opening of the incision, and the insertion of a gauze drain.

II. **Lacerated or Contused Wounds.**—Such injuries are caused by blunt instruments, by machinery, missiles, the wheels of a vehicle, etc., which lead to bruising or crushing of the tissues. They are characterized by the following signs:

1. The **Hæmorrhage** is, as a rule, but slight, since the vessels are torn across irregularly, and not cut cleanly; the middle and inner coats, which give way last, are curled up within the contorted outer coat, forming a barrier sufficient to prevent loss of blood. The vessels, moreover, being elastic, may be pulled out of their sheaths, and may sometimes be seen pulsating upon the surface of the wound.

2. The **Lips** gape less than in an incised wound, and are irregular, torn, and bruised. Layers or portions of dead tissue exist which have to be disposed of before repair can take place, and so this form of wound usually heals by granulation, or, as it used to be termed, by second intention. When a limb is torn completely off, the tendons are often left long, and the muscular bellies project prominently from their fascial sheaths, as flabby congested masses; the skin, moreover, gives way at a higher point than the subjacent structures.

The **Progress** of the case depends largely upon the question whether the wound is or is not aseptic.

In an **Aseptic** lacerated wound it may be possible to bring the edges together by suture or otherwise, and, even though they are a little bruised, healing by a slightly delayed first intention is possible, if drainage is provided. If the wound remains open, dead portions of tissue will probably be absorbed, unless large and resistant, and thus an aseptic granulating surface will result. There may be a little simple traumatic fever for a day or two, but it will be of little consequence, or of no long duration.

If the wound is **Septic**, however, it will run a more marked febrile course, resulting finally in a granulating surface. Three stages may be described in the course of the case, viz.:

(*a*) The stage of injury, resulting in shock.

(*b*) The stage of inflammation and sloughing, with septic traumatic fever.

(*c*) The stage of repair by granulation, or prolonged suppuration, with exhaustion and hectic fever in the worst cases.

The inflammatory period lasts a week, ten days, or more, according to circumstances. The chief dangers to which the patient is exposed are shock, various forms of septic trouble, including secondary hæmorrhage, toxæmia, pyæmia, etc., and traumatic gangrene.

The **Treatment** of contused and lacerated wounds varies with their character, and no absolute rule of practice can be laid down to suit all cases. The following plan of treatment is that usually adopted:

(*a*) **Immediate Treatment.**—The great desideratum in all these cases is to render the wound aseptic. To accomplish this, it is desirable in severe injuries to anæsthetize the patient, and then to scrub the wound and its surroundings with soap and carbolic lotion (1 in 20) by means of a sterilised nail-brush. All foreign bodies must be removed, and dead or doubtful tissues cut away, if unimportant, whilst bleeding vessels are secured by ligature. Ample provision must always be made for drainage, since the carbolic irrigation will of itself cause much exudation; occasionally it may be desirable to make a counter-opening for this purpose. The wound is then drawn together by sutures, and it is advisable to remove ragged and torn fragments of skin with the scissors or knife, if there is sufficient tissue around; an antiseptic dressing of the usual type is then applied. If, however, the skin is scanty and asepsis not assured, it is better to leave the wound open, or, at any rate, only to partially close it, and then to dust it over with sterilised iodoform and pack it carefully with aseptic gauze.

(*b*) **Subsequent Treatment** depends on whether or not the measures adopted to obtain asepsis have been successful. If the wound remains free from infection, nothing special is called for beyond careful dressing; if the edges are in contact, healing by first intention will ensue; if not, the wound will close by granulation or organization of blood-clot. If it becomes septic, and the surface is covered with sloughs, these must be removed by natural or artificial means before healing can occur; the use of antiseptic poultices will expedite matters considerably, but it must be remembered that secondary hæmorrhage may break out when the dead tissues are finally detached. During this period inflammatory fever continues, and the patient's general health must be closely watched. When once a clean granulating surface is obtained, it is treated in the same way as any healing wound, skin-grafting possibly being called for in the more extensive cases.

The question of **Amputation** will sometimes be raised in dealing with the graver forms of lacerated wounds, and although many limbs are now saved which would inevitably in former days have been sacrificed, yet still occasionally no other treatment is possible. Hard and fast rules cannot be laid down as to when to amputate and when not to do so; each case must be treated on its own merits. Apart from the local lesion, the following points will have to be carefully considered: (*a*) The **age and vitality** of the patient. An old person has much less recuperative power than a young one, and hence a damaged limb may often be left in a youth which one would certainly remove in an elderly person. The vitality of the individual is perhaps even more important than the age, for some men at sixty are in a much more healthy and resistant state than others at forty. The habits, as to temperance, etc., must also be taken into consideration, and the existence of general diseases such as diabetes or albuminuria might induce one to resort to radical rather than conservative measures. (*b*) The vitality of the **extremity** injured. A leg has to be sacrificed much more frequently than an arm, since the vitality and reparative power of the latter are so much greater. (*c*) The **septicity** or not of the wound is of the greatest significance, since, if infection can be prevented, the chances of preserving the limb are much improved, and one would then often delay operation, whereas sepsis would turn the scale in favour of radical interference.

As to the local conditions which may suggest or determine the performance of an amputation, one may conveniently divide them into two groups, viz., where amputation is essential, or where it is doubtful.

A. **Amputation** is certainly **called for**—

1. To trim up the stump of a limb torn off by machinery, or cut off by the passage of a railway train over it, or carried away by a cannon-ball.

2. When the whole limb or one complete segment of it has been totally disorganized, or crushed to pulp, though still retaining its connection with the body.

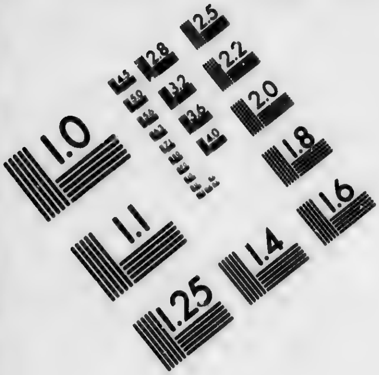
3. In cases where gangrene is imminent or has supervened, especially if it is of the spreading type.

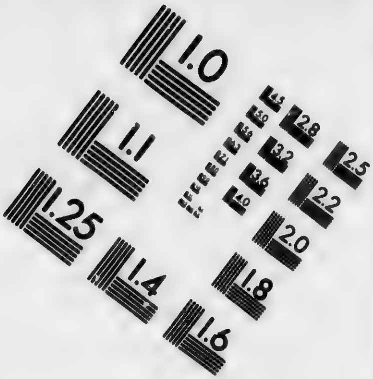
4. When severe septic symptoms, *e.g.*, osteo-myelitis or arthritis, or those of incipient pyæmia, or sometimes those of tetanus, are manifested in a case where an attempt is being made to save the limb; or when exhaustion supervenes from prolonged suppuration.

5. In severe compound contusions of the foot involving the bones and laying open the common synovial cavity. Here the better plan to adopt, as a rule, is to amputate, since septic arthritis and death of the bones is very apt to ensue. The distance of the foot from the centre of the circulation increases the likelihood of gangrene, especially in old people.

B. **Amputation** is **doubtful** in the following conditions:

1. Compound comminuted fractures in parts other than the





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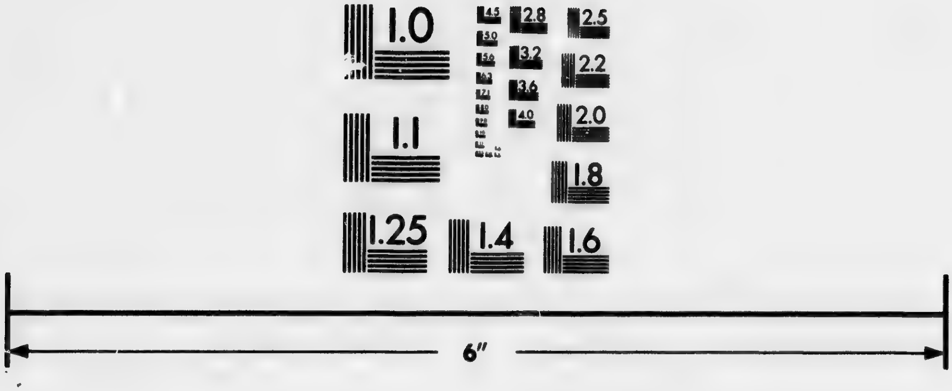

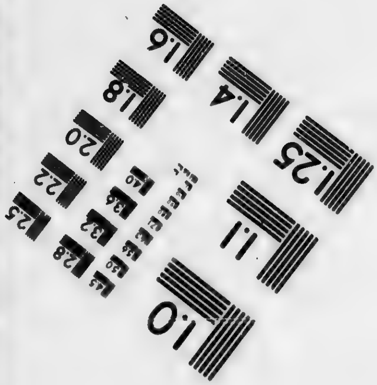

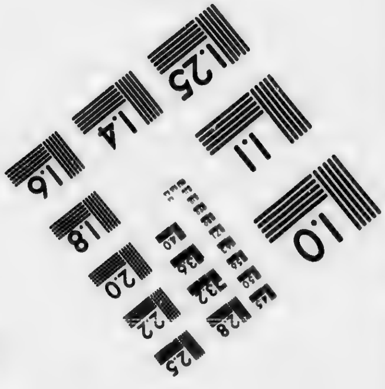

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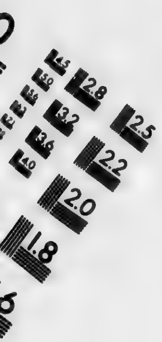
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foot do not *per se* require amputation, even if neighbouring joints have been implicated. By careful attention to antisepsis, free drainage, the removal of detached fragments of bone and foreign bodies, which should usually be accomplished under an anæsthetic, limbs formerly condemned to amputation can not only be preserved, but also restored to a considerable degree of functional usefulness. The final decision will mainly depend on the age, condition, and previous habits of the individual.

2. When the soft parts have borne the brunt of the injury, and have been extensively stripped from the bones, amputation is by no means an essential, provided that they can be restored to their original position, that there is a reasonable probability of their vitality being maintained, and that the utility of the limb will not be hopelessly impaired after the wound has healed. The surgeon has here to carefully balance the risk run by the patient if an attempt is made to save his limb, and the value that the limb if saved will be to him subsequently. For instance, when the muscles of the forearm have been extensively torn up in a machine accident, he has to satisfy himself, even if the vascular supply is satisfactory, whether it is worth while exposing the patient to the risk of grave sepsis, when it is probable that under the best circumstances the limb will be of little practical use.

3. Laceration of the main artery of a limb need not in itself determine amputation; but if in addition to this the bones, veins, or nerves, are injured, and especially in the lower extremities of old and feeble folk, amputation should be undertaken without delay.

As to the **Period** when a limb should be removed after an accident, there is no doubt that, as a general rule, the sooner amputation is performed, the better; the longer it is delayed, the greater the risk of septic infection and absorption. Moreover, experience tells us that, if the limb is removed before reaction from the initial shock is fully established, the impression upon the system is often less severe than if the operation is deferred until traumatic fever has set in. On the other hand, the shock in some cases may be so profound that it is better policy to delay interference until reaction is established; this is especially the case in severe crushes close to the hip-joint, primary amputation in this locality being very frequently fatal. At the same time, if in the opinion of the surgeon shock is being perpetuated by the presence of a crushed limb, it should be immediately removed. When, however, septic fever is present, and it seems desirable to remove the limb, there is no need to wait until defervescence has occurred, as used to be taught; as soon as the septic part is taken away, the fever and concurrent phenomena will also cease, provided that the amputation wound is maintained aseptic.

III. **Punctured Wounds and Stabs.**—These may be brought about by any form of penetrating instrument, from a pin or needle to a sword-thrust or bayonet wound. The external opening may be in itself insignificant; but the great immediate danger is the damage that may be done to deep structures, bloodvessels or nerves being divided, and serous cavities or viscera opened. The subsequent symptoms depend almost entirely upon the question of septic infection, since if it occurs there is always considerable difficulty in efficiently draining the depths of a long and narrow wound, whilst any attempt to close it would be most injudicious. Collections of pus readily form and burrow in all directions.

Wounds resulting from the modern **sword-bayonet**, though very serious from their size and depth, are not so difficult to heal as those inflicted by the old triangular blade. They should be thoroughly syringed out with warm carbolic lotion (1 in 20), well drained, and the skin opening not allowed to close until all discharge has ceased; if necessary, a counter-opening should be made at a dependent spot. Serious hæmorrhage, or paralysis indicating that important vessels or nerves have been divided, calls for immediate opening up of the wound, so as to expose the injured structures, which can then be treated *secundem artem.*

The commonest form of punctured wounds met with in civil practice are those produced by **needles**, which are frequently broken off short in the body. These usually occur about the hands, feet, knees, or nates, and may lead to subsequent trouble. If seen soon after the injury, it is advisable to undertake their immediate removal, a proceeding sometimes exceedingly simple, but occasionally necessitating a deep and difficult dissection. Should the needle not be removed, it frequently travels about the body along the muscular and fascial planes, and there is no knowing where it may lodge or come to the surface, or how long it may remain in the body. It may occasionally find its way into the pelvis of the kidney, and constitute the nucleus of a renal calculus, or possibly, if it enters the gall-bladder, it may cause cholecystitis, and give rise to a formation of gall-stones, as occurred in a case recently treated by one of us.

For the detection of penetrating foreign bodies of a metallic nature, or of splinters of glass or stone, the newly discovered X rays of Röntgen are exceedingly valuable. They are produced by passing a powerful electric current through a modified Crookes tube, or, as it is now termed, a 'focus tube.' This consists of a thin glass tube shaped somewhat like an incandescent lamp, into which are fixed two terminals—one, the negative, concave, and the other, or positive pole, a platinum plate set at an angle so as to reflect the rays generated at the negative end to the convexity of the bulb. A very high vacuum must be present in the tube. If now the limb with the supposed foreign body within it is placed over a dark slide containing a sensitive dry plate, and the tube just above it, so that the convex portion on which the rays impinge is nearest the limb, a skiagram is produced which, on development, shows the osseous tissues, the outline of the limb, and the foreign body, if it exist. Figs. 52 and 53 represent such appearances, the needles being clearly seen.

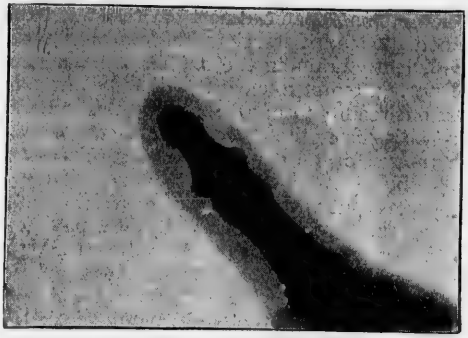


FIG. 52.—SKIAGRAM OF NEEDLE EMBEDDED IN THUMB.

FIG. 53.—SKIAGRAM OF NEEDLE EMBEDDED IN THUMB.

The needle was in this case found quite unexpectedly, the thumb having been examined for some other condition.

A modification of this process has led to the production of the **Cryptoscope**. This consists of a cardboard screen coated with platino-cyanide of potassium or tungstate of soda, and if employed instead of a sensitive plate on the further side of the limb to the tube, the appearances produced can be seen by the naked eye. Since it is possible in this case to move the limb from side to side, or to rotate it, a better idea can be obtained of the position of the foreign body; by simple skiagraphy, it is often impossible to tell on which side of a bone the foreign substance lies.

IV. **Gunshot Wounds.**—It will be impossible in a work such as this to go minutely into the subject of gunshot wounds, but it is essential to indicate what are their most important features, and in what respect they differ from other forms of injury already described.

The character of a gunshot wound varies according to the nature of the projectile, the arm employed, the velocity of the missile, the distance from the body at which the firearm was discharged, the part of the body struck, and the direction of the shot. Considerable changes have taken place in the structure both of the guns and of the projectiles used in modern days, the spherical bullet having been discarded for the conical, greater penetrating power and velocity being the result, whilst the rotation of the bullet derived from a rifled barrel increases the injury. When the angle of incidence is more or less acute, even the modern bullet has a tendency to be diverted from a straight line by muscular or fascial planes, or dense ligaments, so as, in some cases, to make a complete circuit of the body. The wounds are usually more cleanly cut, and less lacerated than formerly, though when a bullet strikes a bone or a solid viscus the destructive effect may be greater. Dangerous wounds may be inflicted by small shot, as, for instance, when one of the pellets enters the eye, whilst the wads or other portions of the cartridge may also be carried into the body. A blank cartridge, if discharged at a short distance, may produce a severe wound, and under such circumstances the skin around is likely to be burned and blackened, leaving a permanent bluish-black tattooing of the surrounding tissues.

The chief features of gun-shot wounds may be enumerated as follows: (*a*) The unknown extent of the injury, since, although there is only a small external opening, the subjacent tissues may be severely lacerated, or large cavities laid open; (*b*) the difficulty of ascertaining the exact track of the missile; (*c*) the risk of septic contamination, which, however, arises rather from portions of clothing which may have been driven in, or from lack of attention to the wound, than from the bullet itself. It is a curious and interesting fact that bullet wounds *per se* are not necessarily septic, the missile, even when lodged in the body, often giving rise to no suppuration, and becoming encapsuled. (*d*) There is always a considerable amount of bruising and laceration of the margins of the wound, so that, if sepsis supervenes, extensive sloughing may follow. (*e*) The depressed mental condition of patients who have attempted suicide by this means also tends to increase the difficulties of treatment.

In the old days great stress was laid on the differing appearances presented by the apertures of entry and exit of the bullet, the former being small and depressed, the latter large, gaping, irregular, and lacerated. This distinction, however, only holds good where the velocity of the bullet is not great; in the present day there may be but little difference between the two.

The **Clinical History** of a gunshot wound is very similar to that already described for lacerated wounds. As an immediate result of the accident, pain is experienced by the individual, as also a certain amount of shock, the degree of these phenomena, however, varying with the situation of the lesion, and the mental preoccupation of the patient. The amount of bleeding necessarily depends on the vascularity of the part, and whether or not large vessels are involved. In the course of a day or two, unless strict precautions are adopted, septic inflammation is likely to develop, giving rise possibly to suppuration along the muscular and fascial planes, or to acute inflammation of the bones and joints if such be injured. Constitutional disturbance of a severe type is associated with these local phenomena, even amounting to pyæmia or septicæmia, and dependent largely on the narrow track through which alone the inflammatory products can be discharged. Secondary hæmorrhage may also arise during this period. Abscesses may form and burrow in all directions, giving rise to sinuses discharging an abundant secretion of pus, and causing convalescence to be much delayed.

The **Treatment** of gunshot wounds must necessarily be conducted in accordance with the general surgical principles already detailed. When the limbs are involved, the rules of treatment laid down on p. 180, etc., should be followed, although the surgeon's practice is liable to be considerably modified by the patient's environment. Conservative measures are often impracticable after a battle if the number of wounded is large.

In the less serious cases, where amputation is apparently unnecessary, the first requisite is to control the hæmorrhage, and to apply a temporary antiseptic dressing or application, such as filling the wound with an antiseptic cream or emulsion. As soon as possible, the wound is thoroughly examined and cleansed, foreign bodies removed, and bleeding points secured. If the bullet can be readily reached, it should be extracted, a counter-opening being made if necessary; but when placed deeply, it may often be left with advantage for a time. If no important structures are divided, a drainage-tube is inserted, and the wound dressed antiseptically. Under no circumstances should an attempt be made to entirely close the external wound.

If, however, vessels, nerves or bones have been injured, the wound should be freely laid open so as to enable the surgeon to secure bleeding-points, or, if possible, to suture divided nerves, or to remove fragments or spicules of bone. When septic inflammation ensues, abscesses should be freely incised as they form, and efficient drainage established. Should serious inflammatory symptoms arise, or if exhaustion from prolonged suppuration follows, secondary amputation may be called for.

In dealing with a bullet which has lodged deeply, various appliances have been introduced in order to locate its exact situation, such as the porcelain-ended probe of Nélaton, or some of the more complicated electrical contrivances, by means of which the needle of a compass is deflected when the bullet is touched. Skiagraphy has also a large field of usefulness before it in this direction.

Gunshot wounds of the chest and abdomen will be referred to hereafter (Chapters XXVII. and XXX.).

V. **Poisoned Wounds.**—The great majority of poisoned wounds are due to some definite micro-organism, and we have discussed their nature and characteristics elsewhere. A few only remain to be dealt with here.

Stings of Insects, such as bees and wasps, may be exceedingly irritating and painful, but are not as a rule dangerous, unless some local complication, such as erysipelas, supervenes, or the stings are very numerous, as when a swarm of angry bees settles on a person, or the part involved is such as to lead to serious swelling, as in the pharynx or tongue, œdema of the glottis possibly arising under such circumstances. All that is usually needed is the application of an alkaline lotion, such as weak liquor ammoniæ. Care must also be exercised to see that the sting and poison sac are not left in the body.

Some varieties of flies and spiders are also extremely virulent, and it is possible that actual disease can be transmitted by the former. Thus, if a fly bites a person after feeding on putrid carrion, some form of septic inflammation may be originated; or, again, anthrax may be spread in this way. Mosquitoes, too, play an important rôle in the growth and development of filariæ.

Snake-bites require but little notice here, as they are exceedingly rare in this country, the common adder (*Pelias berus*) being the only venomous one frequently met with, and even with this the poison is not sufficiently virulent to do much harm unless the individual attacked is a child or a person in a very bad state of health. The poison is conveyed to the wound from the glands and poison sac situated on either side of the upper jaw through fine canals in the specialized teeth, which open at their apices, and these teeth are so delicate in some snakes that it may be difficult to find the wounds so produced. The effects of an adder's bite are not, as a rule, noticed immediately, but come on in the course of an hour or so; extreme prostration supervenes, with a weak pulse, cold clammy perspiration, dilatation of the pupils, and perhaps delirium in bad cases, merging into coma.

The **Treatment** consists in preventing the absorption of the virus by tying a tight ligature above the wound, which should then be laid open so as to allow of free bleeding, and the surface excised or cauterized. The collapse resulting from absorption of the poison is best remedied by the administration of stimulants or the hypodermic injection of strychnine.

In India and other countries many varieties of poisonous snakes are met with, and wounds are frequently fatal; indeed, in India it is stated that 12,000 individuals are yearly destroyed in this way. The symptoms come on rapidly, and are extremely severe, although they are modified according to the variety of snake. The treatment must necessarily be more energetic; probably the introduction of Fraser's antivenine will be the means of saving many a life.

The **Anatomical Tubercle, or Butcher's Wart**, consists in a papillomatous development usually on the knuckles of those who are exposed to wounds either in the dead or slaughter house. It is in all probability a manifestation of tubercular infection, and, indeed, resembles somewhat closely the appearance of lupus when it develops on the hands. Treatment consists in the application of a powerful caustic, whilst in bad cases it is necessary to scrape the surface before cauterizing.

Dissection or **Post-mortem Wounds** have obtained an unenviable notoriety as being fertile in the production of serious inflammatory disturbance, and although the graver forms are less common now than formerly, yet they are still met with occasionally. It is well known that bodies are most virulent within a few hours of death, and hence the post-mortem room is more frequently responsible for these affections than the dissecting room; moreover, the care which is expended upon the preparation of subjects by injecting them with antiseptics still further reduces the dangers which might arise from the latter source.

Inflammatory disturbances may arise under these conditions from several distinct causes:

1. The mere presence of strong antiseptics, such as arsenic, often suffices to irritate any small abrasions, and also to cause tenderness and a little congestion of the matrices of the nails. This, however, is of little importance.

2. The organisms occurring in actual putrid material have no power of attacking living tissues, although considerable irritation may be caused by them if small sores or abrasions are present.

3. Pathogenic organisms are frequently found in bodies soon after death, and are especially virulent when developing in the exudations from serous membranes. Thus, the effusion in septic peritonitis is intensely noxious, and hence the surgeon who operates on the living subject, and the pathologist who examines the body after death, are alike exposed to the greatest risk either

from an accidental puncture or from the infection of some abraded surface; it is also possible for infection to occur through the hair follicles of an unbroken skin.

The lesions originated by any of these means vary in their nature with the method of inoculation, the virulence of the organisms, and the power of resistance of the individual. In the simpler cases all that ensues is a limited irritation of some abrasion or scratch, which rapidly disappears on the application of some sedative or antiseptic lotion. Suppurative folliculitis, or even boils, arise from infection of the hair follicles, and in worse cases the various forms of onychia, paronychia, or diffuse cellulitis, with or without suppuration in the nearest lymphatic glands. Severe toxæmic symptoms usually accompany the latter conditions, and even acute septicæmia may be developed. The immediate treatment indicated for a dissection wound is to tie a ligature or tight handkerchief around the base of the wounded finger, so as to encourage bleeding and prevent the absorption of toxic materials; the part is then well washed under a tap of cold water, immersed in an antiseptic solution, and sucked for some minutes; an antiseptic dressing must then be applied. Any inflammation which arises subsequently must be treated according to the general rules of surgery.

An exceedingly common result of poisoned wounds, whatever their origin, is inflammation of the nail matrix (*onychia*), or of the tissues of the fingers, constituting a whitlow (*paronychia*); and it will be convenient to describe these conditions at this place.

Onychia is almost always due to the infection with pyogenic or other organisms of the matrix, starting at the side or base of the nail under the semilunar fold. Several varieties are described:

1. **Onychia Purulenta** (*Peri-onychia*, or *Ungual Whitlow*) is an affection of the matrix commonly seen in nurses and surgeons, in which suppuration occurs beneath the nail, which is thereby loosened. The condition usually starts on one side, and gradually extends round the semilunar fold and beneath the nail and the bed, until the whole matrix may be affected. When the loosened nail is cut away, the diseased portion of the matrix is found to be converted into granulation tissue. The process is extremely painful and somewhat tedious. The only hope of checking its progress lies in removing with fine scissors, possibly under an anæsthetic, all the loosened portion of the nail, and then touching the exposed granulations with nitrate of silver, whilst the most comforting applications are without doubt linseed-meal poultices, possibly made with hot carbolic lotion (1 in 40), and frequently repeated. At the same time the general health must be attended to.

2. **Onychia Maligna** is the term applied to a somewhat similar condition met with in badly nourished children. The whole

matrix is affected and transformed into granulation tissue, whilst the digit becomes swollen and club-shaped. Treatment consists in avulsion of the nail from its bed, and the application of antiseptic fomentations or poultices, together with iodoform.

3. **Onychia Syphilitica** is a condition met with usually in the secondary stage of the disease, and may arise from injuries inflicted during this period. Considerable dusky inflammatory hyperæmia appears at the base and along the sides of the nail, whilst the matrix is converted into somewhat prominent granulation tissue, and a good deal of offensive pus escapes from the sides. The nail becomes discoloured and shrivelled, and finally separates, perhaps peeling off in layers. Subsequently irregular masses of new nail substance are produced, but it may be long before the nail is at all serviceable, or it may remain rough and distorted for life. Treatment consists in removing the nail completely as early as possible, touching the matrix with solid nitrate of silver, and dressing it with iodoform or black wash. Suitable constitutional measures must also be instituted.

A Whitlow (*Paronychia* or *Panaritium*) is also due to the same cause, viz., septic infection. Four kinds of whitlow are described, of which one is a true cellulitis, another a tenosynovitis, a third is a localized inflammation of the skin, and the fourth involves the bone of the terminal phalanx.

(*a*) The **Subcuticular** whitlow consists merely in a development of pus beneath the cuticle which separates it from the cutis vera. It is very painful, but otherwise is of little importance. A boracic poultice, combined with the removal of the loose cuticle, is all that is needed in its treatment.

(*b*) The **Subcutaneous** whitlow is a true cellulitis, commencing in the pulp of a finger, but often spreading upwards to involve the palm. It is attended with great heat, pain, redness, and swelling, which latter is at first hard and brawny, but later on becomes more boggy, and is associated with much œdema of the whole finger, and even of the dorsum of the hand. It is often difficult, from the tension of the parts, to be certain of the existence of matter. Constitutional symptoms are not, as a rule, very severe, though the intensity of the pain may exhaust the patient. The hand should be elevated, and the finger poulticed. A free incision should be early adopted, and this may be accomplished by fixing the patient's hand under one's own left arm, and cutting in the middle line towards the finger-tip. Occasionally the pus forms at one or other side of the finger, and the incisions must then be suitably modified. The wounds should be dressed antiseptically after such incisions, and no longer poulticed.

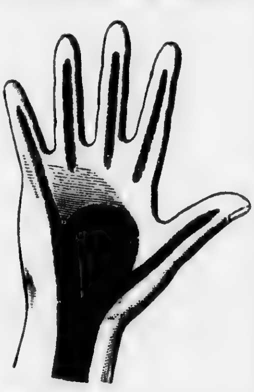


FIG. 54.—DIAGRAM OF SYNOVIAL SHEATHS OF FLEXOR TENDONS OF HAND. (AFTER KEEN AND WHITE.)

(*c*) The **Thecal** form of whitlow is really a suppurative teno-synovitis of the flexor sheaths. The signs are much the same as in the former variety, only more severe, because the process is often more extensive. It is important to remember that the flexor sheaths communicate with the common palmar sheath—always in the case of the thumb, usually in the little finger, but not, as a rule, in the index, middle, and ring fingers (Fig. 54). In the latter case, then, suppuration ceases at the level of the heads of the metacarpal bones; but occasionally it oversteps this limit, and involves the palm in the same way as in the thumb and little finger. Free and early incision must be made to anticipate such extension, and also to limit as far as possible the adhesions which the tendons are liable to contract, or to prevent them sloughing from the acuteness of the inflammation. In neglected cases the pus may burrow to the dorsum of the fingers, necessitating counter-openings; or the periosteum may be affected, leading to disease or death of the phalanges; the interphalangeal joints may also be disorganized. If the palm is involved, care must be taken in incising the abscess not to wound the superficial palmar arch or its digital branches. The knife must cut along the centres of the metacarpal bones, and not higher than the middle of the palm; but an incision may also be called for close to the level of the wrist-joint, and this may be made in the middle line without danger.

(*d*) The **Subperiosteal** whitlow may be merely a complication of the thecal variety; but occasionally it starts as an acute necrosis of the terminal phalanx, arising either idiopathically or as a result of infection from the nail matrix. The inflammation may be limited to the end of the finger, or may spread to the palm. Free incisions, and the removal of the bone, if dead, must in such cases constitute the treatment required.

Repair of Wounds.

In former days five different methods of repair were described, but increased knowledge and further research warrant us in making the statement that there is but one method of repair, which, however, is modified according to the conditions of the wound, and that this process is the same whatever tissue of the body is involved, be it bone, muscle, tendon, or subcutaneous connective tissue.

The **general facts as to the process of repair** may be stated as follows: The margins of the wound are always bounded by an area of tissue in a state of lowered vitality, even if no bruising or sloughing of the parts is present. A certain amount of hæmorrhage has occurred, and the divided vessels are in a condition of thrombosis as far as the next patent branches, which in their turn are slightly dilated, partly as a result of this obstruction and partly from the reflex irritation of the injury (Figs. 55 and 58). The surface of the wound is generally covered with a film of lymph or blood-clot, whilst any spaces left in the interstices of the tissues are similarly filled with clot.

(*a*) The first stage in the process consists in an abundant exudation of small round cells, presumably leucocytes, whose function is to remove all dead or damaged tissue, as well as to break up, disintegrate, and finally absorb, any blood-clot which may be present. These cells are probably derived from the surrounding vessels, and are accompanied by a certain amount of serous oozing, so that we have here the early manifestations of a slight inflammatory reaction, which, if it does not extend beyond certain limits, is a beneficial proceeding. Should it, however, become excessive, as when sepsis is present, injurious results may follow. Much discussion has arisen among pathologists as to whether this stage of repair is to be considered inflammatory or not in origin, and well-known authorities are ranged on either side; the phenomena are, however, so exactly similar to those occurring in the earliest stages of inflammation that it is impossible to draw any accurate line of distinction between them.

(*b*) The exudation of leucocytes is soon followed by the appearance of a number of larger cells with more distinct nuclei, and in which cell division is always accompanied by karyokinesis; these are termed *fibroblasts*, and are supposed to be the active agents in the reparative process. There is some difference of opinion as to the origin of these cells; formerly, in accordance with the Cohnheim dogma, they were supposed to be migrated leucocytes, but more recently the researches of Thiersch, Ziegler, Tillmanns, and others, indicate that they are derived from the multiplication of fixed connective tissue corpuscles or of the endothelial cells lining the neighbouring capillaries. Whatever their origin, they soon form a layer of cellular tissue which lies upon or between the surfaces or lips of the wound, whilst the previously effused leucocytes disappear, some finding their way back into the circulation, and others serving as pabulum for the nutrition of the fibroblasts.

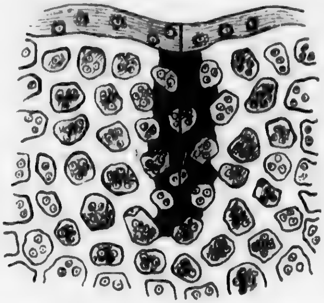


FIG. 55.—EARLY STAGES OF HEALING BY FIRST INTENTION OF A CLEAN CUT WOUND. (AFTER BILLROTH.)

The surfaces are in close apposition; the divided capillaries are filled with thrombi, as also the interstices of the tissues, whilst the capillaries just beyond the thrombosed area are somewhat dilated.

(*c*) The *vascularization* of this cellular layer forms the next stage in the process. This is brought about by the outgrowth from the walls of the nearest capillaries of solid rods of protoplasm (Fig. 57, *a*), which appear first as minute buds, but rapidly increase in length, and may be single or double. They soon bend over to unite with similar threads growing out from other capillaries, or with the wall of another vessel (Fig. 57, *b*), or occasionally they unite with the vessel they started from. The connective tissue cells may also become spindle-shaped, and send out branching processes to unite with the offshoots from the vessel walls. After a time these protoplasmic threads become canalized and hollow (Fig. 57, *c*), and a communication is established between them and the mother vessel, so that blood passes into them. The new capillary wall, at first homogeneous, soon becomes lined with definite endothelial cells, and strengthened by the connective tissue which forms around it. By this means a soft vascular tissue is produced, known as *granulation tissue*, consisting of loops of capillaries supported by a number of large nucleated roundish cells with a varying amount of intercellular substance also present, which, at first homogeneous, soon becomes fibrillated in texture (Fig. 56).

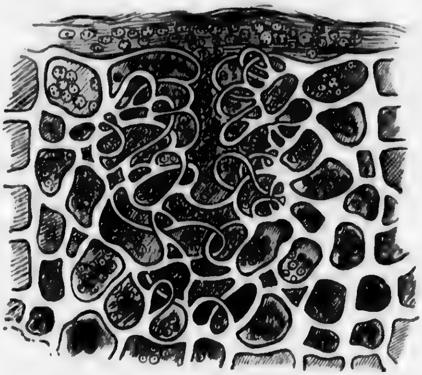


FIG. 56.—LATER STAGES OF HEALING BY FIRST INTENTION. (AFTER BILLROTH.)

The wound is now occupied by a fibro-cellular growth, into which capillaries are extending, constituting granulation tissue, whilst the epithelium has united across the surface.

(*d*) The *transformation* of this granulation tissue into *fibro-cicatricial tissue* is next proceeded with. Formerly it was supposed that the cells of the granulation tissue were themselves transformed into the fibres of which scar tissue is developed, but this idea is now abandoned in favour of one which maintains that the fibrillæ are derived as an intercellular exudation from the fibroblasts. By the contraction of these fibres the cells become flattened out and compressed, and the newly-formed vessels constricted, so that as time passes the scar tissue becomes less and less vascular, and consequently firmer and denser, as well as smaller.

(*e*) Whilst this last stage is in progress, the surface of the wound is covered over with cuticle, which spreads inwards from healthy epithelium in the neighbourhood of the wound, and especially from the deeper layers of the rete Malpighii.

As already stated, the general process of repair sketched above is modified slightly according to the character and condition of the wound. Four chief modifications are met with in practical surgery:

1. **Healing by First Intention** or **Primary Union** occurs in cleanly-cut wounds where the lips are unbruised and brought together, so that no collection of blood or discharge between them is possible, whilst asepsis is also maintained. There is but a microscopic line of damaged tissue, which is easily absorbed, and the process runs a typical course as sketched out above, union being effected in about a week. (See Figs. 55 and 56.)

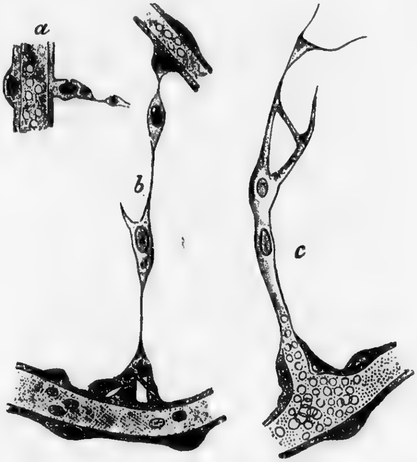


FIG. 57.—NEW VESSEL FORMATION. (AFTER TILLMANNS.)

a, A small bud-like projection from the wall of a capillary; *b*, the union of such buds one with another, or with the branching processes of connective tissue cells; *c*, the canalization of these processes.

2. **Healing by Granulation**, or second intention, as it used to be termed, is met with in cases where there has been definite loss of substance, so that the lips of the wound are not, or cannot be approximated, when the surface of the wound is bruised or damaged so that portions of tissue have to separate by sloughing, or when the advent of sepsis has prevented the occurrence of primary union.

When a small amount of aseptic dead tissue is present, it is removed as previously stated (p. 65) by an invasion of leucocytes from the surrounding vessels, which disintegrate and gradually absorb it. These are followed by the fibroblasts, which form a layer of granulation tissue on the surface of the wound. If there is much slough to be dealt with, the vitality of the granulation tissue cannot be maintained beyond a certain distance from its source of nutrition, and so by a process of simple anæmic ulceration the unabsorbed dead portion is cast off and a granulating surface remains. If the slough is septic, ulcerative inflammation occurs in the adjacent living tissue, which brings about a similar result, though accompanied by suppuration and septic fever. When, however, there is a simple loss of tissue, with no bruising or damage to the tissues (Fig. 58), the course of events is as follows: The blood-stream in the superficial capillaries having been arrested, adjacent ones become dilated, and from these an exudation of plasma and leucocytes results. The plasma coagulates on the surface and forms a layer of fibrin, entangled in the meshes of which are a number of white corpuscles, so that the wound becomes covered with a film of whitish-yellow material known as lymph. This increases gradually in amount and thickness by a further formation of fibroblasts, and is soon vascularized from below into granulation tissue, the process occupying from four to seven days (Fig. 59).

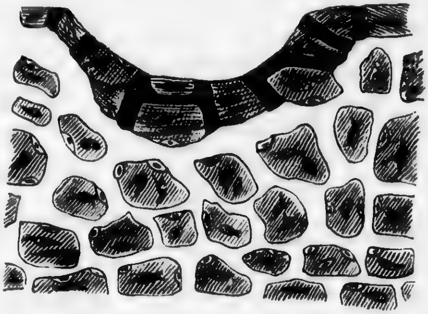


Fig. 58.—Early Stages of a Wound with Actual Loss of Substance, with the Superficial Capillaries thrombosed and the Deeper Ones dilated. (After Billroth.)

The healing of a healthy granulating wound is brought about by the conversion of the deeper layers into fibro-cicatricial tissue, and by the surface becoming covered with cuticle. The contractile tendency inherent in all cicatricial tissue brings about two results from its presence in the base of the wound beneath the superficial layer of granulations: (i.) The surface area of the wound is diminished in all directions, a most important element in the healing process, since if the base is adherent to some dense resisting structure repair is slow and difficult, and the wound may remain open as a so-called chronic ulcer. When the granulating surface is very extensive, contraction may proceed to such an extent as to obliterate many of the vascular channels, and by thus depriving the superficial tissues of their adequate nutrition, the healing process may be indefinitely prolonged. (ii.) The depth of the wound is diminished, partly by the continuous growth of granulation tissue from below upwards, but also by the contractile base lifting the deeper structures to the surface. If the base of the wound cannot be raised, the cicatrix is usually depressed and adherent to the underlying parts.

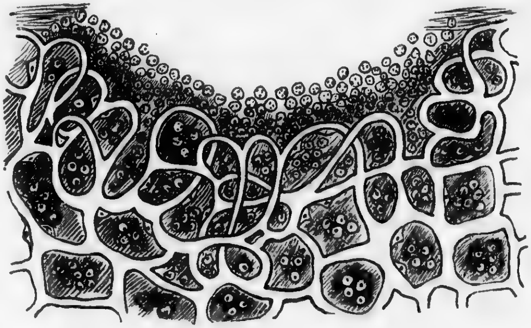


FIG. 59.—LATER STAGES OF HEALING BY GRANULATION. (AFTER BILLROTH.)

During the process of repair the wound takes on the appearance already described as characteristic of a healing ulcer (p. 58).

3. **Healing under a Scab** is a proceeding that can only be permitted in very small wounds, such as superficial grazes and abrasions, and is practically identical with the granulating process, except that, instead of an artificial dressing applied by the surgeon, the lesion is covered by a scab which consists of clotted blood or dried exudation. Such healing is only possible when asepsis exists; otherwise pus is likely to accumulate beneath the scab and give trouble.

4. **Healing by Organization of Blood-clot** is only observed in strictly aseptic wounds where there is definite loss of substance, as in the deep channels made in the treatment of bones thickened by chronic osteitis. Blood is allowed to collect and coagulate so as to fill the cavity, and the surface is covered with protective to prevent irritation from the dressings. The dark coagulum shows

no trace of change for some days, but gradually the peripheral portions become granular and yellowish-white in colour; these in turn become vascularized and transformed into granulation tissue, which in time spreads over the whole surface from periphery to centre, and then healing occurs as described above. The clot is absolutely passive in this process, being infiltrated by leucocytes and removed by degrees, and thus merely serves as a basis of support or scaffolding for the building up of the granulation tissue which replaces it.

A **Scar** is a mass of fibroid tissue covered by epithelium, which has been formed by nature in the repair of a wound. It is at first vascular, and contains cells of the connective tissue type; but after a time, as contraction continues, the cell elements become flattened out, fewer in number and less obvious, the intercellular fibrous tissue more abundant, and the vessels constricted, so that finally a scar becomes well-nigh bloodless. Superficially its colour changes from red to white, and if of small size it may almost disappear, but never absolutely, unless the subcutaneous tissue has not been opened into. When the parts around become injected by any cause, such as sharp friction, the anæmic scar tissue becomes again evident by contrast. Lymphatics, nerves, hairs, and cutaneous glands are all absent, except perhaps at the periphery, and the epithelial covering itself is merely a uniform layer without papillæ.

The **Pathological Phenomena** connected with scars are as follows:

1. **Excessive Contraction,** which may lead to great deformity, especially when the wound has occurred in the flexure of any of the joints. A web-like mass of fibroid tissue then forms, limiting movements, and requiring operative interference. A seriously burned hand may by cicatricial contraction be fused into an unsightly mass, called a club hand, of little use; and, similarly, the chin may be drawn down and practically fixed to the sternum, and the lower lip everted, as the result of a burn on the front of the neck. The *Treatment* of this condition consists in dividing the cicatrix, and thus freeing the parts, during which process it must be remembered that deeper structures of importance, such as the main vessels and nerves, may be adherent to the under surface, and thus be endangered. When once the scar has been divided, there is, as a rule, no difficulty in restoring the parts to their normal positions, although where the contraction has existed for any length of time it may be advisable to do this slowly, even by gradual extension with a weight and pulley, so as to avoid any risk of lacerating the deeper structures, which are usually contracted secondarily. The raw surface formed by the opening out of the contracted part has now to be covered with epithelium by some form of skin-grafting or by a plastic opera-

tion; the majority of cases can be dealt with very efficaciously by Thiersch's method.

2. **Overgrowth of the scar tissue** is sometimes met with, constituting what is known as the false or **Alibert's Keloid**. This most frequently occurs in the scars of burns, but may arise from any cicatrix, presenting itself as a fibroid indurated mass of a dusky red colour, with perhaps a number of dilated vessels coursing over it, which occupies the region of the old scar, and may possibly send claw-like processes into neighbouring healthy structures. It consists merely of a hyperplasia of the scar tissue, but as to its ætiology we know nothing. With the exception of somewhat severe pruritus or itching, its presence entails no inconvenience, although if it occurs on exposed parts it may be very disfiguring. Removal is useless, since it almost always recurs in the new cicatrix. It is therefore better to leave it alone, although the pruritus may be combated by large doses of liquor potassæ. After a longer or shorter interval it often disappears spontaneously.

3. **Ulceration of Scars,** usually the result of defective nutrition, is frequently a very troublesome condition to deal with, as repair is extremely slow.

4. **Painful Scars** arise from either the implication of a nerve terminal in the cicatrix, or the pressure of a contracting scar upon the bulbous end of a divided nerve, as in amputation stumps. In each case further operation is necessary; in the former the cicatrix, or at any rate the painful portion of it, is excised, whilst in the latter the stump must be opened up, and the enlarged end of the affected nerve removed.

5. **Malignant Disease of Scars** takes on an epitheliomatous type, and produces a hard, indurated tumour with everted edges and a thickened base, with usually a good deal of fœtid discharge. The progress of the case is very slow, since the vascularity of the tissue is slight. It is painless from the absence of nerves, and as long as the disease is limited to the scar, no lymphatic implication will be noted. As soon, however, as the malignant growth invades healthy tissues, all the usual phenomena will show themselves. The disease may be freely dissected out, having regard to subjacent structures, and the wound closed by some plastic method.

Methods of Treating Wounds.

It is quite unnecessary in a work such as this to occupy space in describing the many different plans which were adopted by surgeons in pre-antiseptic days in their treatment of wounds; and although even now there are practitioners who scoff at the teachings of Lister, and maintain that merely cleanliness is needed, yet the majority of enlightened men make some profession of using either the antiseptic or aseptic plan of treatment. Unfortunately, failure in carrying out all the necessary precautions leads not uncommonly to suppuration, and we cannot emphasize too strongly the urgent necessity of attention to the minutest details if success is to be attained, especially since so many of the operations now undertaken are only justifiable under such conditions.

The **Antiseptic** plan of treating wounds, originally introduced by Lord Lister, is an outcome of the germ theory of putrefaction. It has for its object the prevention of bacterial development in the wound by the use of chemical agents, capable of destroying, preventing, or inhibiting their growth. Innumerable methods of applying this treatment have been adopted, and multifarious antiseptic agents have been used, prominent among them being carbolic acid, corrosive sublimate, iodine, iodoform, salicylic acid, boric acid, etc. Whilst the practice differs in various surgical schools as to the antiseptics employed and the details of their application, yet the principle in some form or other is now generally adopted. We shall here merely sketch out the usual routine followed at King's College Hospital in undertaking an operation, or in the treatment of a wound.

i. The **hands** of the surgeon must be rendered pure by washing them thoroughly with soap and water; the nails must be cut, if need be, and cleansed, special attention being directed to the reflection of skin at their base, where septic material is so apt to collect; for this purpose a purified nail-brush may be employed with advantage. The hands are then immersed in carbolic lotion (preferably 1 in 20), which penetrates the skin, and acts more efficiently than a sublimate solution. It must be clearly understood that absolute sterility is not essential, though very desirable, since it has been demonstrated that in many a wound that heals by first intention germs are present, though these are not, as a rule, of a pathogenic nature.

ii. All **instruments** are sterilized in a bath of carbolic lotion (1 in 20), which, it must be remembered, takes an appreciable time to destroy microbes, and therefore if during an operation a fresh instrument is suddenly called for, which has not been previously purified, it is not enough just to momentarily immerse it in the solution, but it should be first placed in liquefied carbolic acid for a few seconds, and then rinsed through the 1 in 20 solution. Special care must be directed towards the forceps, to see that the teeth and serrations are free from dried blood-clot and other dirt, so liable to accumulate there. Should an instrument fall on the floor during the operation, it must, of course, not be used again until thoroughly repurified. Boiling the instruments either in carbolic lotion or in a weak solution of bicarbonate of soda (1 per cent.) is also a potent means of rendering them aseptic.

iii. **Sponges**, unless very carefully treated, are a fertile source of septic infection; they must be thoroughly purified in strong carbolic lotion before use, and wrung out of a 1 in 40 solution during the operation. Unless the surgeon can be absolutely certain of the nurse, it is better to use only a limited number of sponges—say two—and for the assistant to cleanse them in a bowl of lotion placed in a suitable position. Portions of wool, gamgee tissue, or gauze, soaked in carbolic or sublimate lotion are advantageously employed when there is any doubt as to the sterilization of the sponges. It is advisable to keep sponges used for tubercular disease or rectal operations separate from those employed in sterile wounds; and it is better to employ wool swabs for any conditions where pus is present.

In cleansing sponges after an operation, the following procedure may be adopted: They are first thoroughly wrung out of cold water, and then placed to soak for some hours in a fairly strong solution of washing soda. They are then again well rinsed in cold or hot water, so as to remove all the soda, and finally immersed in a solution of carbolic acid (1 in 20), in which they are kept till required.

iv. The **ligatures** and **sutures** of catgut or silk should be soaked for some hours in 1 in 20 carbolic lotion before use. Silk requires very thorough purification; in order to prevent the stitch suppuration so commonly seen, it is advisable to boil it thoroughly for some time before placing it in carbolic acid; it should be in loose coils, and not on a reel, as then only the outside strands are reached. Catgut, on the other hand, must not be boiled or immersed in carbolic lotion for too long, as it is apt to become rotten, and break when used.

v. The **skin of the patient** should be shaved prior to operation if the part is at all hairy, and then thoroughly washed with soap and water, and covered with an antiseptic compress for some hours. When the patient is on the table and anæsthetized, a final cleansing is undertaken. The part is first well rubbed with turpentine or ether, to remove all fat and grease, and then with soft soap; finally, it is flushed over with strong carbolic lotion, or even scrubbed with a nail-brush. Corrosive sublimate is sometimes used instead of carbolic acid, but is not so satisfactory, since it is unable to penetrate the skin to the same extent. It must not be forgotten that a very energetic use of carbolic acid will be followed by local irritation, as well as by its absorption into the blood-stream, especially in protracted operations. Again, not only does the quality of the skin vary in different individuals (as may be illustrated by contrasting that of a coal-heaver, who probably bathes once a year, with that of a lady, which is soft, clean, and delicate), but it also differs in various regions of the body, and hence the process of purification must be modified according to the thickness of the integument. Any part where dirt may accumulate demands scrupulous attention, *e.g.*, the umbilicus, external ear, toes, or corona glandis in persons with long foreskins.

When the operation has been completed, the skin around should be again cleansed with warm carbolic lotion, after a piece of dressing has been placed as a protection over the wound. This cleansing should always be accomplished by wiping peripherally away from the centre, and any sponge or swab which has been utilized for this purpose should not be allowed to touch the wound until repurified.

vi. The **area of the operation** or wound should be surrounded with mackintoshes, and these covered by towels wrung out of hot carbolic lotion. The latter are first soaked in a solution of 1 in 20, and then wrung out of the hot 1 in 40 solution, and kept warm until required. During the operation the wound may be occasionally irrigated with a 1 in 40 carbolic solution, or with corrosive sublimate (1 in 2,000); but such is not always advisable, as it tends to increase the amount of subsequent oozing, and is really unnecessary if one is certain as to the aseptic condition of everything employed. When dealing with the peritoneal cavity or the interior of a joint, the less one employs antiseptics the better, since they are always more or less irritating, and lead to desquamation of the endothelial lining, which it is so important to maintain intact. In fact, the rule of practice which we are endeavouring now to establish is the strictest antisepsis for the external parts, but asepsis for the interior of the wound; one cannot always be certain, however, that this ideal has been attained, and then antiseptic irrigation may be resorted to.

vii. Before closing the wound, the surgeon must use every endeavour to secure absolute hæmostasis. It must be well cleansed with a dry sponge wrung out of hot carbolic lotion, and even, if necessary, irrigated; it may be advisable, especially in large wounds of vascular parts, to insert a suitable drainage-tube and stitch it flush with the surface; but in many cases it is possible to dispense with such. The incision is then closed. Wounds communicating with septic cavities, such as the mouth or rectum, should be purified with a solution of chloride of zinc (40 grains to 1 ounce), and then powdered with iodoform, and either left open or lightly plugged; septic contamination is by this means delayed, and even when it does occur, it may be kept under control by frequently dressing and flushing the part.

viii. Finally, a carefully arranged antiseptic **dressing** is applied, and the part bandaged and put on a splint or in a sling, as may best suit the requirements of the case, absolute rest and quiet being essential if rapid healing is to be obtained.

ix. **After-treatment.**—If no drainage-tube has been employed, and the dressing is not soaked through, it may be left untouched for seven or eight days, at the conclusion of which period it is removed, the stitches taken out, and in all probability the wound will be completely healed. When a drainage-tube has been inserted, it is usually possible to take it out at the end of twenty-four or forty-eight hours; there is no advantage, as a rule, in keeping it in longer; it is only required for the removal of the early sero-sanguineous fluid which exudes during the first twenty-four or thirty-six hours. Should the discharge be very abundant and soak through the dressings, there is, as a rule, no need to remove them and redress during the first twenty-four hours; all that should be done is to soak the stained external bandages with 1 in 20 carbolic lotion, and then pack on some more gauze or wool. This may even, if necessary, be repeated a second time.

As to the different forms of **Dressing** which are employed at the present day, much might be written, but we must content ourselves with a few words as to those ordinarily employed. Lord Lister pointed out some years back that the main essentials of a good dressing consisted in its containing some thoroughly trustworthy antiseptic ingredient; in this material being so stored up that it cannot be dissipated before the next dressing; in its being entirely unirritating; and in its capacity to readily absorb any blood or serum that may ooze from the wound. All the original antiseptic dressings, viz., the carbolic and eucalyptus gauzes, and even the alembroth gauze and wool, failed to fulfil one or more of these requirements; but in the double cyanide of mercury and zinc gauze, we have a material which is to all intents and purposes perfect. All that is required is to moisten it with carbolic lotion (1 in 40), and it may then be applied over the wound without fear. Over this fresh portions taken from the stock supply (which is always kept in a mackintosh covering after being sprinkled with carbolic lotion, 1 in 20) are placed, and finally over all a liberal covering of sterilized or antiseptic wool, so as to diffuse the pressure, which is applied by means of careful bandaging. The best material for bandages is butter-cloth, since it is light and adapts itself easily to the outline of the part.

Other dressings, such as boric lint, iodoform gauze, etc., are occasionally employed, but they are not so satisfactory for general use as the cyanide gauze.

Of late years many Continental and American surgeons have been attempting to eliminate the irritating properties of chemical antiseptics by the adoption of what is called **Aseptic Surgery**. In this, asepsis is obtained by means of heat, the most powerful germicide in our possession; the instruments, ligatures, sutures, and dressings are sterilized by placing them for an hour or so in a hot-air chamber, raised to such a temperature as to destroy all germs, or by boiling them. Such a plan has been employed with much success, but requires infinitely more attention to details than does the antiseptic method. Where our assistants are constantly changing, as in a large teaching hospital, and where many hands are engaged in the work, there is much greater risk of failure. Most elaborate precautions are also taken as to the dress both of the surgeon and his assistants, or of any onlookers; whilst operating theatres, tables, etc., are all disinfected in a most careful manner. Resting, however, on the accredited fact that the great proportion of the organisms contained in the air are harmless, and also knowing by experience that the precautions as to antisepsis sketched out above are quite sufficient in order to obtain the most perfect results, we have no hesitation in maintaining that for all ordinary purposes, and especially in large city hospitals, the antiseptic method is far preferable to the so-called aseptic plan.

General Conditions connected with Wounds.

I. **Shock.**—By the term 'shock' is meant a general depressed condition of the nervous system, resulting from some energetic stimulus, which is either transmitted to the vital centres in the medulla from the peripheral sensory or sympathetic nerves of an injured part, or may descend to them from a disturbance of the emotional centres through the nerves of special sense.

Much confusion in the minds of students having arisen as to the precise meaning to be attached to the terms **shock** and **collapse**, we propose here to limit the latter title to one form of shock, in which the symptoms are well marked and usually prolonged, arising either from a protracted operation, or as the evidence of approaching dissolution at the termination of a severe illness; in short, collapse is practically the same as what we describe as torpid shock.

The **degree** of shock experienced in any particular case necessarily varies immensely, from a transient giddiness to profound insensibility, and although it is impossible to foretell the exact effect to be produced by a given injury in any particular case, yet there are certain conditions which in measure regulate the effect produced. The amount of shock may be said to depend upon the four following factors :

(*a*) The *severity and extent* of the injury. This may be calculated in two directions, viz., by the number of sensory nerve terminals affected, *i.e.*, the superficial extent of the lesion, or by the depth to which the injury extends. Speaking generally, the amount of shock varies directly with the depth of the wound, since the deeper forms are due to a greater amount of violence; but in some cases extensive superficial wounds produce a much greater effect than more limited deep ones, owing to the larger number of nerves involved, along which stimuli can be carried to the centres; thus, a generalized scald is more likely to produce fatal shock than the complete incineration of an extremity.

(*b*) The *site* of the injury. The more essential the organ injured, and the more closely it is connected with the chief sympathetic centres, the greater will be the shock; thus, a small wound of the intestine, stomach, or any of the viscera, is much more serious than an extensive accident to one of the limbs. This fact is sometimes of the greatest practical value in the determination of the exact nature of abdominal injuries. When severe shock with abdominal pain lasts for twenty-four hours after an accident, the surgeon may be almost certain that some internal viscus has been seriously damaged, and should at once consider the advisability of performing laparotomy. An exploratory incision is much less likely to do harm in such a case than leaving it alone.

(*c*) The *nervous susceptibility* of the patient is a most important element, for there can be no doubt that the more highly organized the nervous system, the greater will be the amount of shock experienced. Prison surgeons will bear this out, for amongst the coarser and baser types of criminals operations may be performed without an anæsthetic in a surprising manner; amongst negroes and some other tropical races pain is borne with fortitude, and operations are attended with very slight general effects.

(*d*) The *expectation or not* of the injury. When the whole nervous system is maintained in a state of tension, anxiously expecting the receipt of some painful impression, the effect produced will be concurrently increased; whilst if the attention is diverted, and interest actively aroused in other things, the shock at the time is much diminished, though its effects may be subsequently greater. Thus, in the keen excitement and nervous tension of a battle soldiers have often been wounded severely, and yet not known it until later; whilst the pain of the most trifling cut may produce the deepest shock when the patient is in a state of nervous dread and excitement.

Two main varieties of shock may be described, which differ chiefly in their origin and method of production, the symptoms being very similar.

1. **Active Shock with Reflex Cardiac Inhibition.**—It is a well-known physiological fact that, if a frog's abdomen is laid open and the exposed intestine sharply struck, the heart will stop in a condition of diastole, exactly similar to that produced by exciting the cardio-inhibitory apparatus; whilst if the vagi are divided prior to the blow no effect is produced. A sudden crush of the foot with a heavy hammer has a similar effect. That which can thus be experimentally produced in a frog is an illustration of what occurs in the human subject in the shock following sudden injuries. The medullary centres are excited by the afferent stimuli, and inhibition of the heart's action through the vagi is

the result. The abdominal contents are very closely associated with the cardio-inhibitory apparatus, so that not only rupture of the viscera, but even a simple blow on the epigastrium, or drinking a glass of cold water when heated, may prove fatal. Stimuli from any part of the body, as from a severe injury to the extremities, may have a similar effect. Impressions reaching the medulla from the emotional centres, as by the receipt of unexpected news, or from the visual centres by seeing something revolting or objectionable, may similarly react upon the heart and produce the phenomena of shock.

The **Symptoms** vary with the injury inflicted, from a slight momentary giddiness and faintness (known ordinarily as an attack of syncope or a fainting fit) to complete prostration, insensibility, and even death. The pulse is at first small, slow, and weak, but soon becomes extremely rapid, and often imperceptible or irregular; the countenance is pallid and shrunken, and the brow covered with a cold sweat; the respirations are slow and shallow, and the temperature usually depressed two or more degrees. These symptoms are mainly due to a condition of cerebral anæmia (*i.e.*, syncope), and will be followed by a tumultuous and rapid action of the heart, and by a tendency to vomit, when reaction is established, arising from the post-anæmic hyperæmia of the brain.

2. **Torpid Shock from Exhaustion of the Nervous Centres** is the name given to the condition of collapse which supervenes after more prolonged suffering and injuries, such as after protracted surgical operations, even in spite of the administration of anæsthetics. The condition here manifested is much the same as the above, except that the pulse is *always rapid* and weak; the mental and muscular powers are similarly diminished, and reaction is usually associated with vomiting. When a considerable loss of blood accompanies the injury, the more severe manifestations of this form of shock are seen, the patient lying absolutely unconscious and apathetic, and perhaps covered with a cold, clammy sweat; the pulse is scarcely discernible, the features shrunken and cold, the respirations so feeble and unfrequent as to suggest that each one will be the last.

A third form has been described as **Erethistic Shock**, but this is merely a condition in which a depressed state of the medullary centres is present, whilst the mental or muscular systems are more or less active from other causes. Thus, a patient suffering from shock may be restless from the excessive pain of the wound, as is often seen in severe burns and scalds; or, again, he may be intensely restless after great loss of blood; or, lastly, shock may be accompanied by traumatic delirium, a condition of the gravest import. None of these states, however, call for special notice at this place.

Occasionally the evidences of shock are delayed in their appearance for some time after the injury, and come on gradually. Especially is this the case after railway accidents when no great injury has been experienced; for a time the anxiety and excitement are such that no depression is noticed, but as the mental perturbation passes off, the individual experiences symptoms very similar to the above, but probably rather of the nature of neurasthenia than of real shock (see Chapter XVII.).

The **Post-mortem** evidences are not very characteristic, but they all point to a loss of control of the nervous system over the vascular, resulting in anæmia of the brain and superficial parts of the body, and enormous engorgement of the abdominal viscera, lungs, and great venous trunks; the heart contains practically no blood, although it is probable that the right side is much distended at the time of death, especially when due to active shock, subsequently emptying itself by post-mortem contraction. These phenomena are supposed to be explained by a general loss of tone of the vascular system from a reflex exhaustion and paralysis of the vaso-motor centre, allowing the blood to accumulate in the most dilatable parts, viz., the lungs and portal system; it is possible, however, that they are due in large measure to a special nervous mechanism associated with the 'depressor' branch of the vagus which governs the splanchnic area.

Diagnosis.—1. From the general results of *hæmorrhage*. Restlessness and thirst are then prominent signs, together with a sense of dyspnœa, causing rapid respiratory efforts; the mental condition, moreover, is less affected, and the patient is generally sensible; the surface is excessively blanched, and the pulse may have a marked hæmorrhagic wave. 2. In *concussion of the brain* there are superadded to the symptoms of shock those more particularly connected with the region affected, *i.e.*, the intellectual centres, so that unconsciousness is the predominant feature. 3. When *vomiting* is approaching *under* the influence of *an anæsthetic*, the patient's pulse usually becomes weak and rapid, and the countenance pale. This condition closely simulates shock, and is often only distinguished by the progress of the case. Under such circumstances, if vomiting is plainly imminent, it is wise to increase the amount of anæsthetic, as the patient is usually not fully under its influence.

Treatment.—In slight cases very little is needed beyond resting quietly for a few minutes, or the exhibition of some aromatic stimulant to the nostrils, such as ammonia or smelling-salts. In the more severe cases the patient is laid recumbent, with the head low; hot bottles well protected and blankets are applied to the trunk and extremities to maintain and increase the bodily temperature. If able to swallow, a little warm tea or stimulant may be administered; but if unconscious, a brandy enema, or a hypodermic injection of ether or liquor strychniæ, is necessary. It must be borne in mind that the patient has, in most cases, only to be tided over a certain period of depression before reaction naturally follows, so that it is all-important to economize vital power, and not to waste it by over-stimulation, which is also apt to cause excessive reaction later on.

The intravenous infusion of hot saline fluid (1 drachm of chloride of sodium to 1 pint of water) has also been employed with considerable success of recent years. The *modus operandi* is described at p. 213; the fluid should be introduced at a temperature between 105° and 110° F. Several pints may be injected to begin with, the exact amount being governed by the reaction of the patient. If after a few hours symptoms of depression again supervene, the infusion should be repeated.

An important question is often raised as to the advisability of performing an operation during shock. As a general rule, it may be stated that operation should be deferred until reaction has come on, unless the presence of the injured organ, such as a badly crushed limb, is evidently prolonging the condition. Under such circumstances it should be at once removed, and it will be often found that, as the patient comes under the influence of the anæsthetic, his pulse improves, and the state of shock disappears, the anæsthetic shielding the medullary centres from the painful afferent stimuli. Again, it may often be possible to deal with urgent cases without delay by the use of a saline injection into the venous system prior to operation. Prolonged shock after an accident is always a serious symptom, and often indicative of internal injuries; the importance of such must be carefully considered before deciding on the treatment.

Shock may be *prevented* during operation to a large extent by a careful attention to such details as keeping the patient well covered up and as warm as possible, by minimizing hæmorrhage through bloodless methods of operating or the use of forcipressure forceps, and by rapidity of execution. A hypodermic injection of strychnine given just before the operation will also be useful; and it must be remembered that incomplete anæsthesia tends to increase the shock rather than to prevent its occurrence. It may be advisable, in cases where the pulse is very weak, to use ether rather than chloroform.

II. **Traumatic Fever.**—Traumatic fever is that which occurs after the receipt of some injury, simple or compound, or after an operation. Two main varieties may be described:

(*a*) **Simple Traumatic Fever** occurs after subcutaneous injuries, such as sprains, contusions, fractures, etc., and after aseptic operation wounds or compound injuries. It is thus found in conditions where micro-organisms are absent, or, if present, are in such a state as to be practically impotent. The generally acknowledged cause is the absorption from the blood clot or inflammatory exudation of some chemical substance (possibly the fibrin ferment), which has a pyrogenous effect upon the medullary centres. Probably the fever following aseptic operations is largely determined by the use of irritating antiseptics, which increase the exudation, and lead to considerable damage of the tissues ; if mild antiseptics are alone used to irrigate open aseptic wounds, or preferably if no irrigation is employed at all, this so-called 'reactionary fever' will be absent, unless other elements, such as retained serous discharge or accumulation of blood, are present. Occasionally fever is observed in cases where we have no grounds for supposing that absorption of fibrin ferment is taking place; it may then be due to some peripheral irritation, *e.g.*, a badly-fitting splint, and disappears immediately on the removal of the cause.

The symptoms are those of slight fever, reaching 100° or 101° F. within twenty-four or forty-eight hours of the injury, with coated tongue, loss of appetite, etc., gradually passing off in three or four days. If thus limited, it is of no prognostic importance.

(*b*) **Symptomatic Traumatic Fever** is that caused by the absorption either of the products of putrefaction, resulting from the vital activity of non-pathogenic organisms in discharges, blood-clot, or dead tissue ; or from the absorption of the toxines connected with a development of pathogenic organisms in the wound or its surroundings ; or from the supervention of some general infective disorder. All these different states have been dealt with elsewhere, and require no further notice.

III. **Traumatic Delirium.** — Although delirium is merely a symptom which is superadded to others in certain cases, it is occasionally of so pronounced a character as to demand special attention. Three forms are met with :

(*a*) The **Active Delirium**, which accompanies severe injuries, particularly in plethoric, and often in previously healthy individuals, whose environment has been suddenly changed from that of everyday life to a sick-bed in a hospital ward. Septic contamination of the wound is usually present, and the delirious state is associated and runs a parallel course with the traumatic fever. As a rule it is not of a violent type, although the patient may be irrational and restless; he moves the injured part without any evident appreciation of the pain which, if conscious, he must suffer, but he is easily restrained by the exhibition of firmness and tact on the part of the attendant. The symptoms are most marked at night, and commence at the end of forty-eight hours, lasting, as a rule, for two or three days. There is a distaste for food, which, however, can be overcome by gentle persuasion.

Treatment.—Patients in this condition must never be left; the diet should be light, but nourishing; the bowels must be thoroughly opened, and an icebag to the head may be useful. The wound should be freed from any septic accumulation.

(*b*) **Delirium of a Low Muttering Type** is met with in individuals of low vitality, exhausted by dissipation, drink, disease, or faulty hygienic surroundings. It is commonly associated with fever of an asthenic type, such as is seen towards the end of septic or infective diseases. The patient usually lies on his back, staring vacantly upwards, is incoherent, takes no notice of surrounding objects, and is observed to pick at the bedclothes and mutter to himself unintelligibly. There is often, in addition, an involuntary escape of urine or fæces. The mouth is generally open, the tongue dry, brown and cracked, and viscid mucus collects about the teeth (*sordes*).

The **Treatment** should be directed to careful nursing and feeding, as by that means alone can the patient be saved.

(*c*) **Nervous Traumatic Delirium** is observed as a rule in individuals who, previously of intemperate habits, have suffered some serious injury, such as a compound fracture. In such the violent symptoms do not show themselves till about the third day, but are usually preceded by some amount of sleeplessness and wandering at night, or the patient may have short snatches of sleep, from which he awakes semi-delirious. This gradually increases, and is followed by violent delirium of the worst type (*delirium tremens*), in which the patient is haunted by terrifying visions of reptiles, horrible insects, and the like, from which he tries in vain to escape. During this stage of excitement he is with difficulty restrained from jumping out of bed; in many instances these patients are remarkably cunning, and, managing to elude the vigilance of their attendants, will succeed in escaping from the room by the door or window, and so inflict serious, and even fatal, injuries upon themselves or others. There is always a tremulous condition of the extremities and of the tongue, which is white and coated, whilst the bowels are obstinately confined. The pulse and temperature vary considerably, and the skin is often moist and clammy. The violent stage is always followed by profound exhaustion, in which the patient may gradually sink into a state of coma and die. In a case of fractured leg, the struggles of the patient will cause considerable displacement of the limb, and necessitate constant attention to prevent further mischief. The limb should never be fixed to the bed, but slung in a Salter's swing.

Treatment.—In cases where an attack of delirium tremens is considered imminent, either from the previous history of the patient, the tremulous state of his hands and tongue, or his sleeplessness, the best treatment to adopt is to support the strength by suitable food and a medium dose of stimulant, combined with free purging and, if need be, soporifics (chloral, bromide, paraldehyde, or morphia); under such a regimen the symptoms usually soon disappear. In the acute maniacal attacks the patient must be fully controlled and guarded, but with as little manifestation of restraint as possible. Good nourishing food (possibly of a fluid type), with a certain amount of stimulant, should be administered during the quiet intervals, and sleep obtained by the exhibition of drugs, especially morphia hypodermically; a half-grain should be given at first, and more if necessary. Hyoscine ($\frac{1}{200}$ grain) has been occasionally given with advantage, but it must be remembered that it is a powerful cardiac depressant, and has possibly been responsible for some fatal results. Free purging is of course essential.

CHAPTER VIII.

HÆMORRHAGE.

By the term *hæmorrhage* is meant any loss of blood, whether insignificant and immediately arrested by natural means, or more excessive and requiring treatment to prevent its continuance. It may arise from (*a*) trauma, either in the form of an open wound, subcutaneous laceration, or internal rupture, the vessels of the part being divided, torn, or punctured; (*b*) such diseases as tend to weaken the coats of the vessels so that they are unable to resist the intravascular pressure, *e.g.*, cerebral hæmorrhage, the bursting of aneurisms or varicose veins, and some forms of secondary hæmorrhage; (*c*) the extension of ulceration laying open vessels of varying size, both external and internal, as in epithelioma or gastric ulcer, etc.; (*d*) inherited constitutional idiosyncrasy, as in hæmophilia, or diseases, such as scurvy and purpura; and (*e*) some conditions of maintained congestion or hyperæmia, which tend to produce hæmorrhage where the blood-pressure is sufficient to overcome the resistance of the vessel walls.

The **character** of the bleeding differs according to the vessel from which the blood escapes. **Arterial Hæmorrhage** consists in a flow of bright scarlet blood, which escapes at first *per saltum*, *i.e.*, in jets synchronous with the heart's beat, and may be derived, not only from the proximal, but also from the distal end of the divided vessel, if the collateral circulation is sufficiently abundant. **Venous Hæmorrhage** differs from this in the fact that the flow is usually continuous, and the blood of a dark red or almost black colour. If, however, a large vein is wounded, such as the internal jugular, the blood may escape with a very definite spurt, owing to respiratory or other influences. **Capillary Hæmorrhage** is marked by general oozing from a raw surface, the blood trickling down into the wound, and filling it from below upwards. By **Extravasation of Blood** is meant the pouring out of blood from a wounded vessel or vessels into the lax areolar planes immediately adjacent, which become swollen and boggy. The usual constitutional signs will be manifested as a result of such extravasation, and, indeed, fatal hæmorrhage may occur in this way without any escape upon the surface of the body. Subcutaneous or submucous hæmorrhage is, however, also met with in the form of small localized **petechiæ**, arising from injuries, or from changes in the blood or vessel walls (as in purpura, scurvy, and septicæmia). **Epistaxis** is the term given to bleeding from the nose. By **Hæmatemesis** is meant the vomiting of blood; it may either have been swallowed, as in some cases of fractured base of the skull, where the pharyngeal mucous membrane has been torn, or it may have originated from the upper part of the intestinal tract. The blood is usually curdled and brownish in colour, somewhat resembling coffee-grounds, from the action of the gastric juice upon it. **Hæmoptysis** is the title given to the escape of blood from the air-passages, whether it result from injury or disease. **Hæmaturia** is a condition in which blood is passed in the urine; its nature and source will be discussed elsewhere. By **Melæna** is meant the passage of dark tarry blood with the fæces. It is always the evidence of disease or injury to the intestine sufficiently far from the anus to allow the blood to become altered in character by the action of the intestinal juices. Blood derived from the rectal mucous membrane usually retains its bright red colour.

Constitutional Effects of Hæmorrhage.

If the hæmorrhage is severe, as from division of a large artery, death results from syncope. The surface of the body becomes cold, clammy, and pale; the lips, ears and eyelids, livid; the patient gasps, his respirations become quick and sighing, and death ensues after perhaps a few convulsive twitches of the limbs. If consciousness is retained at all, patients often complain of the sight failing, and a sense of increasing darkness, immediately preceding the fatal termination.

If the hæmorrhage is not so great as to kill immediately, the patient faints, and on recovering is in a condition of severe collapse and weakness, which continues for some time; he is also liable to recurrent attacks of syncope, any one of which may be fatal.

If the hæmorrhage is more gradual, but continuous, as in cases of piles or uterine fibroids, the patient becomes profoundly anæmic, and the lips, ears, and conjunctivæ pearly white; there is dyspnœa owing to the insufficient amount of blood present, and in consequence the patient is extremely restless, tossing about in bed. Any sudden exertion, and even sometimes the attempt to sit up, is followed by a sensation of faintness; noises are heard in the ears, the sight becomes dim, or even temporarily lost (amblyopia), and severe headache may be complained of, all arising from cerebral anæmia. The pulse often becomes what is known as *hæmorrhagic* in character, *i.e.*, frequent, large, and compressible, but collapsing entirely between each beat, and markedly dicrotic.

These peculiar features are due to the sudden passage of a small amount of blood through a vessel which is practically empty and entirely collapsed. From the defective *vis-a-tergo*, œdema of the extremities may result. After such an occurrence, the patient may continue in a state of anæmia for a considerable time.

Children and elderly people bear the loss of blood particularly badly ; but whereas children rapidly recover from the immediate effects, elderly people do not.

General Treatment of Hæmorrhage.

When the loss of blood has been severe, the patient must be kept quiet with the head low, whether syncope is present or not. Stimulants may be necessary to maintain the heart's action, but should be given with discretion for fear of re-starting the bleeding. If death seems to be imminent, the arms and legs should be bandaged, or the abdominal aorta compressed in order to confine the blood as much as possible to the head and trunk.

'No patient should be allowed to die of hæmorrhage.' Such was the dictum of the late Mr. Wooldridge, of Guy's Hospital, based on a knowledge of the value of transfusion and infusion. By **Transfusion** is meant the transference of blood from one individual to another ; by **Infusion**, the injection into the vessels of the recipient of some fluid which can temporarily take the place of blood, and the success of the latter method has in some hands been so great that the former has practically fallen into disuse.

Transfusion may be accomplished by two methods, the direct and indirect. *Direct or immediate transfusion* consists in injecting the blood of the donor directly into the vessels of the recipient by means of some apparatus, such as Aveling's. The objection to this method is that an individual can rarely spare sufficient blood to be of any real use, and hence the results obtained are, as a rule, most unsatisfactory. *Indirect or mediate transfusion* is carried out by whipping the blood obtained from some healthy individual or individuals so as to remove the fibrin, and after straining through fine linen it is injected, either pure, or diluted with saline solution.

During the last few years it has been recognised, however, that the *success* of this proceeding *depends on* the introduction of a sufficient *quantity* of fluid as a temporary substitute for the blood which has been lost, *rather than* on its *quality ;* for it has been proved that the transfused blood of another person is rapidly destroyed and eliminated. Hence transfusion has now been replaced to a large extent by what is known as **Infusion**, which consists of injecting large quantities of some bland fluid into the vessels, and by this means greatly improved results have been obtained. All the apparatus needed is a metal cannula, the end of which is bulbous, blunt, and bevelled, which can be tied into a vein, and connected by means of a rubber tube with a reservoir containing the fluid (Fig. 60). A vein, *e.g.*, the median basilic or internal saphena, should be exposed, tied below and opened by a longitudinal or oblique incision; the cannula, filled with lotion so as to exclude air, is then inserted and tied in. The amount injected must vary with the circumstances and the effects produced, but, to be efficacious, some *pints* are, as a rule, needed; even 4 or 5 pints have not uncommonly been employed for the purpose. As to the material, a warm saline solution is the best,

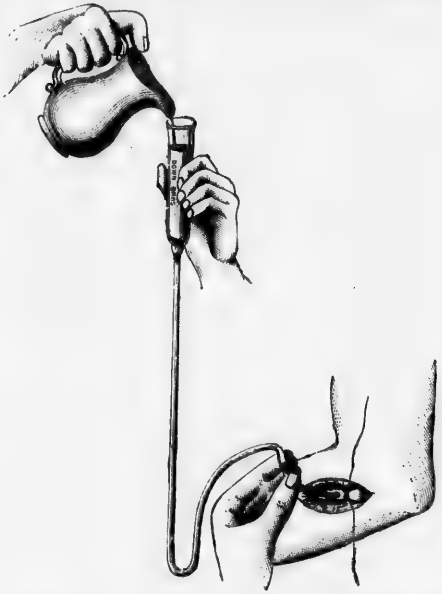


FIG. 60.—INFUSION INTO VEIN OF FOREARM. (DOWN BROTHERS.)

and may consist of the following ingredients: Chloride of sodium, 50 grains; chloride of potassium, 3 grains; sulphate and carbonate of soda, of each 25 grains; phosphate of soda, 2 grains; and water, 1 pint; but a simple solution of the chloride of soda, a drachm to the pint (or about ·5 per cent.), at a temperature of 105° F., will accomplish all that is necessary, and a common syringe or hydrocele cannula will be found in an emergency quite sufficient apparatus. As a rule, one injection is all that is called for in dealing with hæmorrhage, but where shock is present it may require to be repeated two or three times. The dried crystals of salt should be dissolved in a small quantity of boiling water, so as to sterilize it, and this is then diluted to the required bulk.

Another plan which we have used with success consists in the introduction of warm fluid into the rectum, or through an aspirator needle connected with a tube and funnel into the loose connective tissue of the buttock or abdomen. In the latter case the funnel must be held at some height in order to gain sufficient pressure, and by this means several pints may be introduced.

Of course, in each of these methods all apparatus must be most scrupulously sterilized, either by boiling for some minutes or by effective immersion in carbolic lotion.

Natural Arrest of Hæmorrhage.

This can best be described under two headings, viz., (1) the temporary arrest, and (2) the permanent. The processes occurring are much the same, whether arteries, veins, or capillaries are involved; but since the arrest of arterial hæmorrhage has been more thoroughly investigated, and is the most important, we shall deal mainly with it.

The **Temporary** arrest of arterial hæmorrhage is brought about by three main factors:

(1) The **coagulation of the blood**, which is the *sine quâ non*. It occurs in and around the vessel, and without it death would ensue from the merest scratch. The greater the loss, up to half of the total amount of blood in the body, the more coagulable it becomes.

(2) **Diminution in the force of the heart's action** always follows hæmorrhage, from anæmia of the cerebral centres, a beneficial provision of Nature whereby coagulation is facilitated and the flow of blood checked. Unless the syncope is profound, stimulants should therefore be carefully avoided, for fear of causing a recurrence of the bleeding by increasing the power of the heart's beat.

(3) **Changes in and around the vessel** play a most important part in completing the process.

They consist in the **retraction** of the artery within its sheath by reason of its inherent longitudinal elasticity; if, however, it is only partially divided (or, as it is called, 'buttonholed'), this condition cannot obtain, and the hæmorrhage is more likely to continue. As a result of this retraction, the rough and uneven inner lining of the sheath is exposed, and upon this the blood coagulates as it flows, thus gradually producing what is known as the **external coagulum.** At the same time the transverse muscular and elastic fibres in the vessel wall cause **contraction** of the open mouth, and thus, as the force and calibre of the blood-stream diminish, the external coagulum is able to increase in size by fresh deposits of fibrin, until at last its resistance is too great for the diminished cardiac impulse to overcome, and the sheath is filled with clot, which extends to the divided mouth of the vessel. From this an **internal** coagulum also develops, which gradually extends upwards as far as the next patent branch. By such means the hæmorrhage is totally arrested for the time being, and preparation made for—

The **Permanent** closure of the wound in the artery. The exact mechanism of this step has excited much discussion, and somewhat divergent views have been expressed as to the means whereby it is accomplished. Probably this want of agreement has arisen from the fact that the conditions, under which the observations were made, were not uniform, some observers having apparently drawn their conclusions from transverse sections alone, and others from longitudinal. In reality, it merely consists of a modification of the general process of repair.

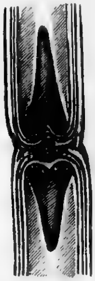


FIG. 61.—EARLY STAGE OF OBLITERATION OF ARTERY AFTER LIGATURE.

The thrombus is seen above and below the site of ligature, that on the proximal (upper) side being the larger; commencing cell infiltration of the bases of the clots is also indicated.

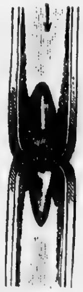


FIG. 62.—LATER STAGES OF THE SAME PROCESS.

The clots are shrinking, and the lowest portions are being transformed into granulation tissue. Proliferation of the tunica intima is also seen, reaching beyond the apices of the clots.

In both these diagrams the arteries have been represented of normal size for clearness' sake; in reality, the lumen of the vessel would be much contracted.

After the cessation of the hæmorrhage, the internal coagulum, soft in consistence and dark red in colour, extends from the mouth of the vessel, or from the site of the ligature, to the next collateral branch (Fig. 61). The vessel wall contracts upon this coagulum, with which, however, it does not unite, except at and near its base. As a result of the injury, a simple plastic arteritis is set up, evidenced by a hyperæmic condition of the vessel wall, due to dilatation of the vasa vasorum, and its infiltration with leucocytes, which also invade the coagulum and cause its base to become decolorized and firmer. The leucocytes break up the clot, traversing the natural lines of cleavage which result from its contraction, and gradually remove it, a few giant cells, probably derived from the leucocytes, occasionally assisting in this process. The tunica intima of the vessel wall proliferates concurrently, causing a secondary infiltration with the larger fibroblastic cells in the part of the thrombus which is adherent to the vessel wall (Fig. 63); whilst a growth of cellular buds, which gradually increase in size and encroach on the lumen of the vessel, springs up in those parts where the apex of the clot lies free and unadherent (Fig. 62). Thus, the base of the clot is transformed into a cellular mass derived from proliferation of the tunica intima, and by the development of new vessels

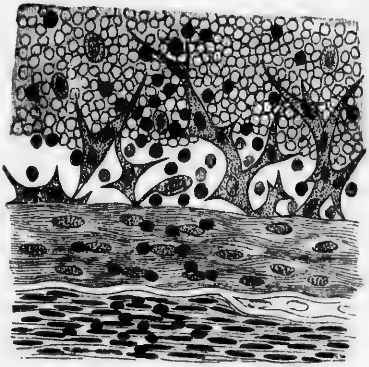


FIG. 63.—EARLY STAGE OF ORGANIZATION OF THROMBUS, TO SHOW THE INFILTRATION OF THE CLOT WITH LEUCOCYTES AND CONNECTIVE TISSUE CELLS DERIVED FROM THE ENDOTHELIUM. (TILLMANNS.)

from the vasa vasorum into granulation tissue; whilst the cellular buds which grow from the walls, and extend nearly to the next collateral branch, are also similarly changed. The free conical extremity of the clot contracts, and is gradually removed, partly by the activity of leucocytes which infiltrate it from the base, partly by the erosive action of the surrounding granulation tissue. A similar set of changes occur at the distal side of the ligature in an artery tied in its continuity, although the thrombus is smaller and less firm. The ligature itself may be infiltrated by leucocytes, and replaced by granulation tissue, or may be encapsuled. A rod of granulation tissue is thus developed, blocking the vessel, and this, by the usual process of repair, is transformed into a firm cicatricial cord in the course of a few months (Fig. 64).

The arrest of hæmorrhage from veins and capillaries is, as a rule, more easily accomplished, the collapse of the walls, together with the formation of the external coagulum, being sufficient for this purpose. The later steps are similar to those occurring in an artery, except that there is but little internal coagulum. In capillaries, unless there is present some constitutional condition, such as hæmophilia, the mere falling together of the walls is sufficient to allow coagulation to take place, and thus stop the bleeding.

Surgical Treatment of Hæmorrhage.

Very many different methods are needed, under varying circumstances, for the effective arrest of hæmorrhage. It must be remembered that digital pressure over the bleeding-point will always temporarily check the most furious outburst whilst means for its permanent stoppage are being arranged.

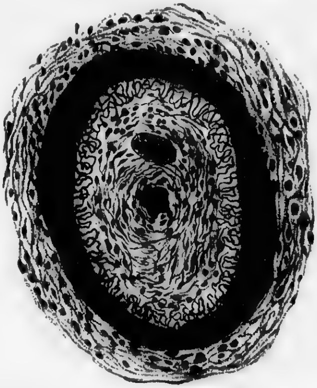


FIG. 64.—ORGANIZED THROMBUS IN VESSEL, SHOWING THE NEWLY FORMED CONNECTIVE TISSUE OCCUPYING THE LUMEN OF THE VESSEL, AND VASCULARIZED FROM THE VASA VASORUM. (TILLMANNS.)

Two giant cells are seen in the centre.

Where the bleeding, though profuse, does not come from any one particular vessel, the surgeon can avail himself of the following resources, which are arranged more or less in the order in which they would have to be used:

1. **Cold** may be employed in the form of ice, cold water or lotion, or simple exposure to the air, all clots, rags, pledgets, etc., being removed for this purpose; it must, however, be remembered that ice applied directly to an open wound may convey sepsis. Such treatment is most valuable for general oozing from vascular structures or into cavities, such as the mouth, vagina, or rectum.

2. **Position.**—Where the bleeding is from one of the extremities, especially the lower, **elevation** is a most important factor in arresting it. The veins are emptied by the force of gravity, and this is always followed by a reflex contraction of the arteries, a proceeding of which surgeons avail themselves in order to exsanguinate a limb previous to applying the rubber tourniquet in operations which we desire to render as bloodless as possible.

3. **Direct Pressure.**—The skilful application of an antiseptic dressing, combined with pressure, is often effectual in arresting hæmorrhage. General oozing from cut surfaces, which can be brought into apposition, as from an amputation wound, may be checked by applying a firm bandage over them, or by incorporating a purified sponge, wrung out almost dry, in the dressing. In cavities or hollows, either natural or made by operation, bleeding may be stopped by plugging with a purified sponge, or by strips of dressing, or by graduated layers of antiseptic wool. This form of packing has in a large measure taken the place of the old 'graduated compress,' which consisted of layers of lint devoid of antiseptic qualities, gradually increasing in size, superposed one over the other. Any such dressing, if successfully applied, should be retained firmly in position for twenty-four hours, after which, if no further hæmorrhage has occurred, the bandages may be slackened, but the plug should, if possible, not be removed for some days.

4. **Hot Water** of a temperature of 130° to 160° F. may be employed with advantage during, or immediately after, an operation. A certain proportion of carbolic acid or corrosive sublimate should be present to render the water aseptic, or it should have been previously boiled; it must also be sufficiently hot, otherwise bleeding is rather encouraged than checked. It is supposed to act by stimulating the involuntary muscular fibres of the vessel wall to contract; but probably the coagulation of the albumin of the blood is an important factor, as unless the water is hot enough to blanch the surface of the wound the bleeding is not stayed.

5. **Chemical Agents** may be used to check oozing from spongy parts, or bleeding from organs or cavities which cannot be reached by the surgeon. If they are applied locally, and act primarily by causing coagulation of the blood, they are known as **Styptics**, or astringents. Such are the liquor ferri perchloridi or pernitratis, tincture of matico, tannic or gallic acids, alum, nitrate of silver, fibrin ferment, styptic colloid, etc. If the drug is administered internally, and acts by increasing the coagulability of the blood, or by causing constriction of the vessels, it is termed a **Hæmostatic**—*e.g.*, opium, ergot, turpentine, hamamelis, acetate of lead, chloride of calcium, etc. In applying a styptic, it is essential that the surface of the wound should be thoroughly cleansed, and all coagula removed. A portion of the dressing dipped in the

solution is applied to the surface, or the drug is sprinkled upon it in the form of a powder. The objection to the use of these agents is that healing by primary union is liable to be interfered with.

6. **Cauterization** is not very largely employed for the arrest of hæmorrhage, except from bones and from tissues thickened by inflammation, where retraction and contraction of the vessels are difficult. It need in no way interfere with primary union if the skin is not touched, for the minute sloughs formed are quite aseptic, and will either be absorbed or cast off in the discharges. The great objection to this method is the risk of secondary hæmorrhage when the sloughs separate. The cautery is sometimes used for the bloodless removal of vascular tumours, either as a galvano-cautery, or a Pacquelin's knife, or the ordinary clamp and cautery. It must be remembered that, in order to effectually seal the mouths of the vessels, the cautery must be at a dull red or black heat; a bright red-hot iron cuts through a vessel as cleanly as a knife, and does not stop the hæmorrhage.

When the bleeding is more serious, and originates from some definite vessel or vessels, other and more vigorous measures will have to be adopted. Digital pressure will suffice to arrest it for a time whilst preparations are being made to ligature or otherwise treat the wounded vessel. If possible, a ligature should be applied with antiseptic precautions, but other means are used:

1. **Acupressure** was introduced by the late Sir James Simpson as a method of checking hæmorrhage in order to obviate the use of ligatures. The introduction of aseptic absorbable animal ligatures has made such a method only necessary in exceptional circumstances. Four different plans of applying acupressure have been described, but the principle underlying all is the same. A needle is passed either under the vessel from the skin, or over the vessel from the surface of the wound, and, if applied accurately, such is quite sufficient to stay the bleeding. With it, however, is sometimes combined the pressure of a loop of silk or wire passed figure-of-8 fashion around the ends of the needle; sometimes, moreover, the needle is introduced in a direction parallel to the vessel, and then twisted so as to pass transversely under it, producing a certain amount of torsion as well as compression.

2. **Forcipressure** is a plan of stopping hæmorrhage by crushing the divided end of the vessel between the strong and deeply serrated ends of a pair of forceps with scissor handles provided with a catch; those known by the name of Spencer Wells are the most convenient. In dealing with small vessels, it is quite sufficient to leave the forceps applied for a few minutes, perhaps twisting them before removal; whilst with the larger it is advisable also to apply a ligature. In deep wounds in which it would be difficult, or almost impossible, to tie the vessel, the forceps may be incorporated in the dressings, and not removed for twenty-four hours.

3. **Torsion** was used as a means of sealing the ends of divided vessels before antiseptic ligatures were introduced. It may be applied in two ways, viz.: (*a*) **Limited Torsion**, which is employed for the larger vessels. The artery should be drawn out of its sheath for about half an inch with one pair of forceps, and held close to the tissues by another pair applied transversely, whilst the grasped end is twisted sufficiently to thoroughly close it; it should not, however, be twisted off (Fig. 65). (*b*) **Free Torsion** is used for the smaller vessels which cannot be so completely isolated from surrounding structures; the vessel is laid hold of with its sheath or connective tissue covering, and twisted as much as necessary.

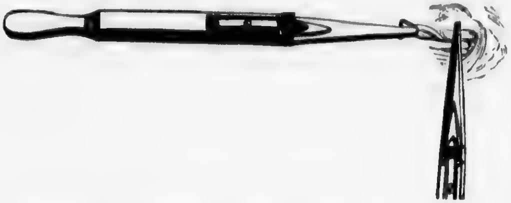


FIG. 65.—METHOD OF APPLYING LIMITED TORSION TO A LARGE VESSEL.

The **effect** of torsion is that the inner and middle coats are ruptured just above the spot grasped, and tend to curl upwards into the lumen of the vessel, whilst the outer coat is twisted up beyond (Fig. 66). A coagulum forms upon the injured structures, and the subsequent processes to secure permanent occlusion are similar to those described above. The **advantages** claimed in favour of torsion are that it is easier to twist the vessels than to tie them, that there is less liability of secondary hæmorrhage, and that no foreign body is left in the wound. As to the ease of application, it is doubtful whether torsion has any advantage over ligature, and certainly when antiseptics are employed the two last statements do not hold good, for secondary hæmorrhage is practically unknown in aseptic surgery, and the catgut ligature cannot be looked upon as more of a foreign body than

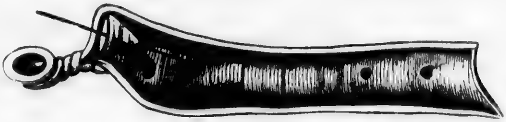


FIG. 66.—EFFECTS OF TORSION ON AN ARTERY.

the damaged end of a twisted vessel. It is, however, occasionally useful in plastic work, where exact co-aptation of raw surfaces is indispensable.

4. **Ligature** is at the present day the most common method for arresting bleeding from a definite source.

The **materials** used have varied considerably from time to time. Originally silk or hempen threads well waxed were employed, and inasmuch as no steps were taken to purify them, and as they had always to separate by a process of ulceration, cutting their way through the vessel walls, it is not surprising that secondary hæmorrhage frequently followed. The ends of the ligature were left long and hanging out of the wound, and were occasionally pulled on by the surgeon to ascertain if they were ready to come away. Since then efforts have been made to obtain a ligature of sufficient strength to secure the vessel, of sufficient resistance to maintain its hold in spite of being soaked in the body fluids, and yet of such material as to be either finally absorbed or so pure and unirritating as to become encapsuled in the tissues. Catgut suitably prepared is the material most commonly in use, and inasmuch as commercial catgut, even when rendered aseptic by immersion in carbolic acid, becomes soft and unravelled, and is absorbed too rapidly, it is hardened and rendered more resistant by steeping it for twelve hours in a solution of chromic acid (5 parts of gut to 1 of chromic acid in 100 parts of water), and subsequently for twelve hours in 100 parts of sulphurous acid solution. It is then dried, and is of a greenish colour. It should always be immersed in carbolic lotion (5 per cent.) for some hours before use.

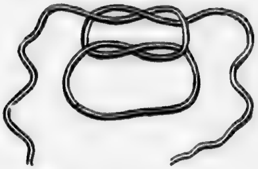


FIG. 67.—REEF KNOT.

Carbolized or sterilized silk is another good agent to employ, whilst animal tissues, such as kangaroo tendon and strips of ox aorta, have their advocates.

Ligatures may be applied either to the divided end of an artery in an open wound, or to an artery in its continuity, the effects and final means of occlusion being in both cases very similar.

When applied *to the open end* of a divided vessel, care should be taken to select a ligature the thickness of which is proportionate to the lumen of the vessel to be tied. The artery should be cleanly picked up with forceps, so as to include as little surrounding tissue as possible, and where a sheath exists, should be withdrawn from it. The ligature is then passed round it and tied in a knot which will not slip, *e.g.*, the reef knot (Fig. 67). When the application of a ligature is difficult, as in very dense fibroid tissue, it may be advisable to pass it under the vessel by means of an ordinary curved needle, and then to tie it.

When a vessel is to be secured *in its continuity*, the surgeon has the advantage of being able to choose the spot to which to apply the ligature, so as to interfere as little as possible with other anatomical structures of importance, and to give every assistance to the collateral circulation, whilst not influencing the formation of the internal coagulum by the too close proximity of a branch. Details of such operative procedures will be found in Chapter IX.

Effects of Ligature—1. On the **Vessel Wall.**—The immediate result, if the vessel has been tied in the usual way, is to divide the internal and middle coats, which are separated from the outer and curl up within the lumen of the vessel, whilst the outer coat is constricted and thrown into folds within the grasp of the ligature. If a vessel is tied in its continuity, the same effect is produced on each side (Fig. 61). An internal coagulum soon forms upon the proximal side of the block, becoming adherent to the base. The changes already described, by means of which the artery is obliterated and transformed into a fibro-cicatricial cord, then manifest themselves in due order. An exudation of plastic lymph and cells occurs into the sheath and around the ligature, and if the latter is aseptic, the whole is embedded in this plastic mass, which undergoes the ordinary changes seen in repair until a firm cicatrix forms. If the ligature, however, is *septic* and irritating, it has to cut its way out through the vessel wall by an ulcerative process akin to the separation of a septic slough, thus exposing the patient to the risk of secondary hæmorrhage from the disintegration of the internal coagulum. The period at which a septic ligature is separated varies with the size of the vessel, from a week or eight days for an artery the size of the radial or ulnar, to twelve or fourteen days for the subclavian or carotid.

Of late years, however, an old idea has been resuscitated, and has gained a considerable amount of support from some surgeons, viz., that occlusion of a vessel is satisfactorily accomplished by merely bringing the walls into close apposition by an animal ligature of suitable size, and that division of the inner and middle coats is not only unnecessary, but prejudicial, and tends to favour secondary hæmorrhage. Where asepsis is fully maintained, satisfactory occlusion follows either plan; but it appears to us that the division and curling up of the inner and middle coats must facilitate the deposit of fibrin and process of repair. At any rate, it would seem safer to apply a ligature to a main vessel on the face of a stump with sufficient tightness rather than to err on the other side. In cases where, perforce, the artery must be tied at a spot where extensive atheroma or calcareous degeneration is present, it may be advisable to use broad animal ligatures (such as strips of ox aorta, as suggested by Barwell), and only to tighten the knot sufficiently to occlude the vessel with as little damage to the coats as possible, whilst the same plan may also be adopted in dealing with arteries of great size, such as the innominate.

2. The **Ligature** itself undergoes changes, which result in its partial or total absorption, if such be possible, or in its becoming encapsuled if absolutely unabsorbent. The leucocytes attack any soft material, such as silk or catgut, insinuating themselves amongst the fibrillæ, and finally remove them by the same digestive power which leads to the absorption of a small aseptic slough. Multinucleated cells are often present, and probably take some part in the process. Ordinary unprepared catgut swells up in warm blood serum in half an hour, forming a pulpy mass, which is rapidly removed; but when it has been steeped in solutions of sulphurous or chromic acid, it becomes more resistant, and takes a considerable time to disappear, varying with the method of preparation. The ordinary chromicized gut usually lasts for about a fortnight. Finally every trace of it disappears, and its place is taken by a ring of fibrous tissue. Silk is similarly attacked and removed, but much more slowly. Other animal substances employed are dealt with in the same way, and even silver wire is not unaffected, its surface becoming roughened and slightly eroded.

3. The effect on the **Circulation** is the same, whether ligature or any other plan of occlusion is adopted. The passage of the blood through the vessel ceases, and its proximal end as far as the next patent branch, though remaining somewhat distended for a short time by the impact of the blood-stream, soon begins to contract after the coagulation of its contents, and is ultimately converted into a fibrous cord, which may or may not be pervious for a short distance. In rare cases, where an artery has been tied in its continuity, the channel has been known to re-open by canalization of the cicatrix. Blood is conveyed to the vessels of the limb below the ligature by anastomosing branches which rapidly undergo dilatation, and establish a *collateral circulation*, sufficiently free to maintain as a general rule the vitality of the part. These collateral branches become permanently enlarged, lengthened, and tortuous, and their walls thickened. If for any reason the collateral circulation is insufficient, gangrene is likely to supervene, starting in the parts furthest away from the centre of the circulation, or in the structures of least vitality, and spreading upwards until a part is reached which receives enough blood to keep it alive.

Arterial Hæmorrhage.

Three forms of arterial hæmorrhage are described, viz., primary, reactionary, and secondary.

Primary Arterial Hæmorrhage is met with under two conditions —from an open wound, or where an artery is ruptured or punctured subcutaneously, so that extravasation into the tissues occurs, constituting either a severe bruise if the artery is small, or if the vessel is large what is commonly termed a 'diffuse traumatic aneurism,' a term which we consider extremely misleading. The general rules for the surgical treatment of these conditions are exactly the same, and although the agent employed to finally arrest the bleeding varies according to the surgeon's personal predilections, yet the underlying principles hold good in all cases. We shall limit ourselves mainly to speaking of the ligature, as we almost always employ this agent.

A. **Primary arterial hæmorrhage from an open wound.** The blood is here poured forth upon the surface, and escapes freely, so that the full constitutional effects are experienced.

The principles that guide us in the **Treatment** of primary arterial hæmorrhage were first recognised by the late Mr. John Bell, but the importance of acting upon such principles, and not trusting to the Hunterian plan of ligature at a distance, was first fully insisted upon by Guthrie, whose large experience, confirmed by that of later surgeons, demonstrates their accuracy. They may be enunciated as follows:

1. *That the vessel must be secured at the part wounded*, an operation to expose the bleeding-point being undertaken if necessary. However much the part may be infiltrated with blood or pus, the rule of cutting down to expose the wounded vessel is to be adhered to, with one or two exceptions noted below, and this for two reasons: (*a*) It is often impossible to know the exact source of the hæmorrhage unless it is laid bare. Thus, the bleeding from a punctured wound of the front of the leg, which was apparently derived from the anterior tibial artery, was proved on incision and careful dissection to come from the peroneal, the puncture having passed between the bones. In the axilla and groin such mistakes are readily made. (*b*) Proximal ligature of a vessel at some distance above the bleeding spot is very commonly insufficient to arrest the hæmorrhage, since the collateral circulation will tend to maintain it, or, though apparently effective for a time, reactionary hæmorrhage is very likely to ensue.

2. *That both ends of the wounded vessel must be secured* if it is completely divided, whilst if it is only punctured, a ligature must be placed on each side of the puncture, and the complete division of the vessel effected. The ease with which collateral circulation is established justifies such treatment in the case of all arteries of large size. Thus, where the facial artery is divided, jets of blood are emitted from each end quite freely, and with nearly as much force from the distal as from the proximal. Occasionally the distal end of the vessel may have retracted amongst the infiltrated tissues to such an extent as to render its isolation impracticable. The surgeon must then trust to plugging of the wound from the bottom, but not until every effort has been made

to secure it. When a vessel has been divided close to the main trunk from which it arises, it practically corresponds to a punctured wound of the trunk, and must be treated as such by double ligature above and below the opening.

It is only needful to undertake the measures detailed above in cases where primary hæmorrhage is actually proceeding. If it has been once arrested, it is unnecessary to search for the bleeding spot unless the patient is very faint and collapsed, and the surgeon has reason to anticipate that a large trunk has been injured. Under such circumstances it may be needful to seek for and tie it at once, otherwise recurrent hæmorrhage is likely to ensue when the heart's action becomes more vigorous.

There are a few exceptions to the general rule of tying a wounded vessel at the injured spot, *e.g.*, where the depth of the dissection needed might endanger important parts, as in dealing with the deep palmar and plantar arches, or with the secondary branches of the carotid.

In the actual treatment of any particular case, the hæmorrhage should be temporarily arrested by compressing either the bleeding point with the thumb or finger, or the main trunk at a favourable spot nearer to the heart, against some resisting structure, such as a subjacent bone. The *common carotid* is controlled by grasping the neck from behind, and compressing the artery by the fingers placed along the anterior border of the sterno-mastoid against the transverse process of the sixth cervical vertebra (Chassaignac's tubercle). Such pressure will also control the vertebral and inferior thyroid vessels. The *subclavian* is to be compressed in the third part of its course against the first rib by the finger or thumb placed immediately behind the clavicle, the palm of the hand resting over the shoulder. A good deal of force is required in order to maintain the pressure, and this may be gained by superimposing the fingers or thumb of the other hand. Where the pressure is to be kept up for some time, the handle of a door-key well padded may be employed in the same way. The *facial* artery is controlled by compressing it against the lower jaw just in front of the masseter muscle. Bleeding from the *labial* and *coronary* arteries is commanded by inserting the index finger into the corner of the mouth, and compressing the lip between it and the thumb outside. The *temporal* artery should be compressed against the zygoma just in front of the ear, the *occipital* at a spot about 1¼ inches from the occipital protuberance against the superior curved line. To control the *brachial* artery, the arm should be grasped from behind, and the fingers pressed inwards along the inner margin of the biceps against the humerus. The *radial* and *ulnar* arteries are easily commanded just above the wrist by using both hands to grasp the forearm, one for each vessel. The *abdominal aorta* is temporarily controlled in slim individuals with ease by pressure through the abdominal wall against the spine at a point a little above and to the left of the umbilicus, *i.e.*, just above its bifurcation; in stout persons this is impossible. The *common femoral* artery is best compressed just below Poupart's ligament against the ramus of the os pubis. The surgeon should stand on the same side of the patient as the artery to be controlled, and use either the finger-tips or thumbs to press the vessel backwards against the pubic ramus. The fingers of one hand placed over the other may sometimes be necessary to maintain sufficient command, or the thigh may be encircled by the two hands, and one thumb laid over or above the other. Care must be taken not to let the vessel roll to one side or the other and so escape compression. When the artery has to be controlled for some time, as in an amputation, the hands may be used alternately, the one to rest the other. Such pressure will suffice for the temporary arrest of hæmorrhage from any part of the lower limb. If it is desirable to control the *anterior and posterior tibial* arteries close to the ankle during operations upon the foot, the assistant who steadies the limb accomplishes this by grasping the toes with one hand, and with the other compressing the vessels, the posterior tibial at a spot a finger's breadth behind the internal malleolus, the anterior midway between the two malleoli.

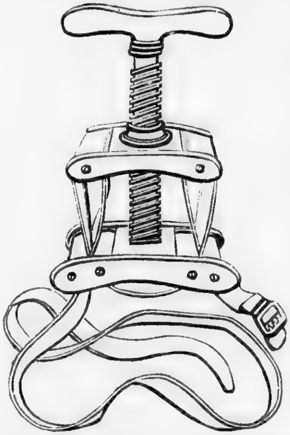


FIG. 68.—PETIT'S TOURNIQUET.

As digital compression cannot, however, be comfortably maintained for long, *mechanical compression* of a limb as by tourniquet (Fig. 68) or elastic bandage must be resorted to. Possibly the screw tourniquet will be the best to apply, as it can be relaxed and tightened again as often as is necessary during the operation. In some cases it is advisable to exsanguinate the limb by elevation before applying the tourniquet. The wound is then, if need be, enlarged by incisions, which whilst freely laying the parts open should inflict the least possible damage on surrounding structures. All coagula should be removed, and the wounded vessel looked for. It may be needful to relax the tourniquet, and allow a jet or two to escape, in order to ascertain its position. Both ends should be sought for and tied, a proceeding easier said than done. This especially applies to the distal end, which retracts, and often does not bleed at the time of operation, but may break out when the collateral circulation becomes established.

B. For **Subcutaneous Rupture of an Artery**, see p. 236.

Recurrent, Intermediate, or Reactionary Arterial Hæmorrhage.

Such are the terms applied to bleeding which recurs within twenty-four hours of an accident or operation. Its occurrence is an evidence of the failure of the means employed to permanently arrest the primary loss of blood, and may result from two main causes: (*a*) Defective application of a ligature, which slips off, perhaps, from including within it other structures as well as the arterial wall; or (*b*) the coagula lying in the mouths of divided vessels are not sufficiently firm to withstand the increasing blood-pressure which supervenes after the shock has passed away, or which may be due to excitement or the injudicious administration of stimulants. As a rule, it is due to the second of these causes, and is then not very serious, inasmuch as it can only arise from the smaller vessels, all the larger ones having, it is presumed, been recognised and tied during the operation. The term should, however, not be applied to the oozing of blood or blood-stained serum so common after operations, but only used for those cases which demand treatment. Considerable pain and tension may be caused by the accumulation of blood in the wound.

Treatment.—Elevation and the pressure of a firm bandage are often quite sufficient to arrest this form of bleeding; but if unsuccessful, it will be necessary to open up the wound, wash it out with hot or cold lotion, and tie any vessel found bleeding. The actual cautery may even be employed to check oozing from cicatricial surfaces, and if it is not allowed to touch the skin, and the wound kept aseptic, no delay in its healing need be occasioned. Should the bleeding persist, antiseptic plugging must be resorted to.

Secondary Hæmorrhage.

Under this title are included all forms of hæmorrhage from wounds, which occur after the lapse of twenty-four hours. It is usually due to sepsis, and was formerly very common, being a frequent cause of a fatal termination; but since the introduction of antiseptic surgery it is but little seen in the practice of those who attend conscientiously to its details. Where antisepsis, however, cannot be efficiently carried out, as in the mouth, pharynx, etc., it is still met with.

The **Fundamental Cause** in the production of secondary hæmorrhage is without doubt a **septic condition** of the wound. This may act in various ways. Thus, in a vessel entirely divided, the cocci may gain entrance through the open mouth to the internal coagulum, and by causing its disintegration break down the barrier which Nature had raised against such an occurrence. This process is assisted by an ulcerative form of periarteritis, which leads to the maceration and softening of an absorbent ligature, and to weakening of the vessel walls. It is in this latter way that secondary hæmorrhage is induced in vessels ligatured in their continuity, the loss of support due to the opening up of the septic wound being also an element of danger. We desire here to emphasize the marked alterations in all the conditions existing in a septic as opposed to an aseptic wound. In the latter it is not only the clot in the lumen of the vessel which is relied on to prevent accidents, but the vital action of all the tissues is calculated to work in the same direction, that of ensuring the patient against hæmorrhage; in fact, the occurrence of secondary hæmorrhage in an aseptic wound is practically impossible. On the other hand, when sepsis supervenes, a destructive process replaces that of repair, and the activity of the part is temporarily paralyzed by the toxic influence of the micro-organisms and their products.

Various other conditions may be mentioned, however, as **Contributory Causes** of secondary hæmorrhage: (i.) The ligature may be coarse, irritating, or septic, or it may consist of material too readily absorbed. (ii.) Its mode of application may be faulty. Thus, it may have included other structures, and so become loose, offering an insufficient bar to the blood-pressure; or the sheath may have been opened too freely, and thus the vitality of the vessel wall dependent on the vasa vasorum will be diminished. (iii.) The ligature may have been placed too near a branch immediately concerned in the establishment of the collateral circulation, or where there is a considerable back flow, or at a spot where longitudinal tension is experienced, especially if the part is not kept absolutely at rest. (iv.) The condition of the arterial wall at the site of ligature may be unhealthy, being possibly the seat of atheroma or fatty degeneration, a most important complication if the wound becomes septic. (v.) The state of the blood may be unfavourable to the repair of any wound, whether in an artery or not, *e.g.*, in albuminuria or diabetes; or it may not coagulate satisfactorily, causing the internal coagulum to be inefficient. (vi.) Increase of the blood-pressure after the ligature of a vessel may lead to secondary hæmorrhage, as in plethora, Bright's disease, traumatic fever, or from injudicious excitement or the unwise administration of stimulants.

The **Phenomena** are usually preceded by those of septic contamination of the wound, to which a slight occasional loss of blood is added. This continues with more or less frequency and severity, but tends to increase until either the patient is worn out by the constant repetition of small losses, or is destroyed by one or two severe gushes from the larger vessels. The earlier the bleeding occurs, the less serious it is, as it probably comes from the smaller vessels, and can be easily dealt with. When, however, it does not supervene till late, as on the tenth or twelfth day, it usually arises from the larger trunks, and is increasingly severe. When it originates from a vessel tied in its continuity, it generally comes from the distal end, and that for the following reasons: (*a*) The internal coagulum is here less firm, and forms later than at the proximal end; (*b*) the pressure at the distal side of the ligature, which is at first nil, is continually increasing as the collateral circulation is established, whilst proximally it gradually diminishes as the vessel contracts, and the blood-flow is deflected into other channels; and (*c*) the main vasa vasorum always run into and along the vessel wall in the same direction as the blood-stream. Hence the effect of isolating the artery in its sheath and ligating it is to diminish the vitality of the arterial tunics and to impede repair just below the point of ligature.

The **Treatment** is a matter of grave anxiety to the surgeon until the wound gets into a healthy state, inasmuch as he can never be certain that it will not break out again, although the bleeding may have been temporarily stayed; hence such a case must be most carefully watched. If the wound is in a limb, a tourniquet should be lightly adjusted above it as a precautionary measure, so that at a moment's notice it may be tightened.

When arising *from an artery entirely divided across*, as in an amputation stump, elevation of the part, exposure to the external air, bathing it with cold lotion, and then redressing it and firmly bandaging, may be all that is needed in the early and mild cases. A recurrence will necessitate the reopening of the wound, and the application of ligatures to the bleeding points, if practicable. The actual cautery may be employed where the tissues are too rotten to hold a ligature. Means should be adopted to remove septic sloughs, as by a Volkmann's spoon, and if possible to render the wound aseptic by swabbing it out with strong carbolic lotion (1 in 20), with pure carbolic acid, or with solution of chloride of zinc. The wound should then be powdered with iodoform, packed with cyanide gauze, and firmly bandaged. If occurring later in the case, the wound should be freely opened up, and an attempt made to secure the bleeding vessel. If this fails, owing to the sloughy or septic state of the tissues, the artery must be tied just above, or re-amputation performed. When the bleeding comes from the main vessel near the trunk, as after amputation at the shoulder or hip, proximal ligature can alone be depended on, should local treatment be unsuccessful.

When coming *from an artery tied in its continuity*, the same means as indicated above should be adopted in the early stages. Later on, the treatment varies a little according to the situation. If from a vessel of the trunk, such as the carotid or iliac, the wound must be freely opened up, and the artery secured again above and below, whilst every effort is made to combat the septic condition by plugging with antiseptic materials. Failing this, if proximal ligature is impossible, one can only trust to pressure. In the arm, after using cold, pressure, and elevation, one would re-tie above and below through the original wound. If this fails, a ligature should be applied higher up through a separate incision, or finally amputation be performed. In the leg, however, it is scarcely wise to attempt re-ligature at a higher spot, owing to the less abundant collateral circulation. If the hæmorrhage ceases, gangrene is very likely to ensue; whilst if the latter does not supervene, hæmostasis will probably not be effected. Under such circumstances amputation must be undertaken without delay.

Venous Hæmorrhage.

Bleeding from the smaller veins rarely requires much attention, in that the walls, when once divided, rapidly collapse, and thus effectually check further loss of blood; but if the larger veins are involved, a very considerable amount may be lost, the blood welling up in a dark, purplish stream from the wound, and rendering its arrest the more difficult from the fact that, except in veins of the largest size, there is no definite jet or gush to guide one to the wounded spot. **The dangers** of venous hæmorrhage are fourfold: (1) The constitutional symptoms arising from the actual loss of blood, details of which have been given above; (2) the thrombus which forms may become displaced, and give rise to serious symptoms as an embolus; (3) the possibility of septic infection of the thrombus lying in the mouth of the vessel, and of pyæmia developing therefrom, must not be forgotten; and (4) the **entrance of air into veins**, which, though an occurrence, fortunately, but rarely met with, is fraught with the most urgent danger to the patient. The air becomes churned up in the cavities of the right side of the heart, forming a spumous, frothy mixture amongst the columnæ carneæ, which the heart can only with difficulty eject; thus the circulation is brought to a standstill in spite of forcible cardiac contractions, and the patient dies from anæmia of the lungs and brain.

The **Cause** of the entry of air is usually the wounding of some vein in what is known as the 'dangerous region' of the neck or axilla, but occasionally it may occur in other positions. There is but little blood-pressure within the veins at any time, but during inspiration the movements of the thorax exercise an aspiratory or suction effect upon the blood in the veins of the neck, a most important element in the maintenance of the venous flow. Any condition which tends to prevent the collapsing of the walls of the veins, or brings about what is termed their **canalization**, predisposes to this accident; thus, they may be held open at spots where they pierce the deep fascia, or by muscles—*e.g.*, the platysma—which by their contractions can have a similar effect.

If the coats are thickened by inflammation, or surrounded by indurated tissue, or button-holed as by excision of a portion of the walls or division of a branch close to the main trunk, or if undue traction is exercised upon the pedicle of a tumour containing a wounded vein, then the orifice may remain patent, and air is readily sucked in. It has been demonstrated both by experiments on animals and also by clinical experience that a certain amount of air can be admitted without doing much permanent harm.

Signs.—The entrance of air into a wounded vein is accompanied by a hissing, gurgling, or sucking sound, which is quite characteristic. A few bubbles of air may also be seen clinging about the aperture in the vessel. The effect of this accident is to produce sudden and severe faintness, and if the patient is conscious, a feeling of dyspnœa and distress, which is partly cardiac in origin, partly due to obstruction to the flow of blood through the lungs. The pulse becomes rapid and almost imperceptible, the pupils widely dilated, and death usually follows, preceded perhaps by convulsions, although the fatal issue may be postponed for a few hours or, it is even stated, days. If the patient survives, no after-effects remain.

Treatment.—This accident should be prevented, if possible, by observing the greatest care in dealing with all veins in operations about the neck. Should it, however, occur, any fresh entrance must be at once checked by placing a finger over the bleeding point or pouring lotion into the wound. The vein should be secured by ligature as soon as possible. Compression of the chest has been recommended by some authorities in order to squeeze out the air that has entered; but there is little chance of attaining this end. To combat the general symptoms, it is essential to maintain a good supply of blood to the brain. The head should be lowered, and, if need be, the limbs raised and bandaged or the abdominal aorta compressed. Stimulants and artificial respiration may be used with advantage in order to maintain the heart's action or to overcome the pulmonary obstruction. Warmth and friction should also be applied to the extremities.

Treatment of Venous Hæmorrhage.—The same means to a large extent must be employed as for arterial hæmorrhage, but it is less frequently required, since the veins collapse naturally, and thus the bleeding stops. When small veins are divided, they may be ligatured or twisted, if need be; but it is never advisable to ligature the whole circumference of a large vein if it can be avoided, since, when such is punctured or torn, the wounded point can often be secured without encroaching upon the calibre of the tube. In amputations it is usual to tie both the main artery and vein. Where it is difficult to reach a vein in order to tie it, plugging of the wound may be resorted to.

Capillary Hæmorrhage.

This is usually of little significance. It is characterized by a general oozing from the wounded surface, the blood trickling down to fill the cavity from the bottom. It may be very abundant from inflamed parts, and especially from fibro-cicatricial tissue, which prevents the closure of the vessel mouths. It can usually be arrested by a little pressure, or by the application of cold or hot water, or by styptics, cauterization, or plugging of the wound.

Methods of dealing with Hæmorrhage from Special Sources.

Carotid Artery.—Treatment is impossible unless the surgeon is on the spot, when both ends should be tied.

Jugular Vein.—Tie, or stitch, if possible, without occluding the whole lumen.

Secondary Branches of the Carotid.—It may be difficult to secure the divided ends of these vessels either in the neck or head, *e.g.*, in a cut throat or a punctured wound of the internal maxillary. Under such circumstances, ligature of the external carotid between the superior thyroid and lingual has been recommended as more satisfactory than tying the common carotid (Guthrie, Cripps), in that the cerebral circulation is not thereby affected.

Middle Meningeal Artery.—Trephine over a spot 1½ inches behind the external angular process of the frontal bone, and 1½ inches above the zygoma; scoop away or wash out the clot; secure the bleeding-spot by ligature, passed, if need be, under the vessel by a full-curved needle, or by forcipressure, or plug the canal in the bone with gauze or sponge, where needful increasing the trephine opening downwards by cutting pliers.

Vertebral Artery.—The source of such bleeding may be difficult to ascertain, as it is scarcely possible to compress this vessel without also including the carotid; and hence mistakes in diagnosis have often arisen. It may be feasible, however, to control the carotid alone by pinching it up by the fingers placed on either side of the sterno-mastoid, without interfering with the vertebral. *Treatment* must follow the usual course, viz., of cutting down and tying at the bleeding point. To do this the incision must be enlarged, or a new one made along the posterior border of the sterno-mastoid in order to define the transverse processes of the vertebræ. In the upper part of its course, the vessel may be secured by clipping away a transverse process if necessary, due care being taken of the nerve roots; otherwise, plugging of the vertebral canal, or the use of styptics, must be depended on. It is most essential that the carotid should not be tied by mistake in these cases, as thereby more blood is directed to the vertebral trunk, and the bleeding is correspondingly increased.

The **Internal Mammary Artery** rarely calls for treatment, since a punctured wound of this vessel is usually complicated with some graver mischief to heart, liver, or lungs. If recognised, tie at the bleeding spot, possibly removing a costal cartilage to gain access. The vessel lies about ½ inch outside the border of the sternum.

Intercostal Hæmorrhage usually results from penetrating wounds also involving the rib, and is not easily stopped, on account of the position of the vessels in the groove. *Treatment.*—Incise the periosteum longitudinally along the lower border of the rib, and detach it and the vessels from the groove; or remove a portion of the bone, and thus expose the bleeding point; or in some cases a suture passed round the rib a little above the injury has sufficed; or, again, pressure may be employed by pushing a piece of aseptic gauze, like a pocket, through the wound into the pleural cavity, and then stuffing it tightly with wool or strips of gauze, so that on pulling upon it the vessel may be effectually compressed.

Wounds of the **Vessels of the Extremities** require treatment according to the principles enunciated above. Only one or two require special mention.

Wounds of the **Palmar Arches** were formerly much more dreaded than they are at present, when thorough antisepsis and the use of the elastic tourniquet allow us to explore the depths of a wound without much danger or difficulty. The position of the wound will usually indicate whether the bleeding comes from the superficial or deep arch, but in case of doubt it is well to remember that pressure on the ulnar trunk mainly affects the superficial arch, whilst pressure on the radial will chiefly influence the deep. A wound of the superficial arch should present little trouble in treatment, as it can be readily secured by catch forceps and ligature; but the deep arch is not so easily dealt with. It lies just over the bases of the metacarpal bones, and to expose it the wound may be freely enlarged by a longitudinal incision, and the tendons turned on one side or separated. It may be possible to secure the vessel by forcipressure forceps, and these may be left on for twenty-four hours if a ligature cannot be applied. Of course the strictest asepsis is needful in such cases, and passive movement of the fingers must be early undertaken, in order to prevent troublesome adhesions. Failing such means, or in septic wounds, a modification of the old graduated compress may be employed; the wound is carefully and thoroughly plugged with gauze, and over this the fingers are firmly bandaged. The patient is kept in bed, and the arm elevated. Pressure on the main vessels above is scarcely necessary if the compress is accurately applied. The bandages should be relaxed at the end of twenty-four hours, but the deep dressing should, if possible, not be touched for three or four days. If, in spite of this, bleeding recurs, the main vessel or vessels of the limb must be tied. Ligature of the ulnar and radial at the wrist is generally insufficient to control it, as there is often a communicating branch of some size passing from the anterior interosseous to the deep arch, and hence it may be needful to secure the brachial artery, ascertaining first, however, by pressure that such would be efficacious; for occasionally there is a high division of the brachial, or a vas aberrans may exist, which may compel the surgeon to tie the third part of the axillary.

Bleeding from the **Plantar Arch** must be conducted on exactly similar lines.

The **Gluteal, Sciatic,** or **Pudic** arteries may be wounded by stabs in the buttock. *Treatment.*—Enlarge the wound in the direction of the fibres of the gluteus maximus, *i.e.*, downwards and outwards, and secure the bleeding vessel. The gluteal trunk emerges from the pelvis at the junction of the middle and inner thirds of a line from the posterior superior iliac spine to the great trochanter; the pudic crosses the ischial spine at the junction of the middle and lower thirds of a line from the posterior superior iliac spine to the tuber ischii. The sciatic emerges from the pelvis just above and a little external to the latter spot. The pudic may also be divided in the perineum by a penetrating wound. Failing ligature of any of these arteries at the seat of bleeding, the main trunk of the internal or common iliac may need to be secured.

Hæmophilia.

By hæmophilia, or the hæmorrhagic diathesis, is meant a congenital or hereditary disease characterized by a tendency to persistent and uncontrollable bleeding from slight wounds, whether open or subcutaneous. This condition is often associated with extravasation of blood into the joints, and certain consecutive phenomena. The family history of such a case is always interesting, the disease being usually transmitted through the females to the males of a succeeding generation, whilst the former often escape entirely. The pathological cause of this affection has not been ascertained, no change in the vessels or constitution of the blood having yet been discovered. Unless hæmorrhage is actually occurring, nothing abnormal is noticed, but any injury is sure to be followed by excessive bleeding; spontaneous subcutaneous ecchymoses frequently occur, as also bleeding from the mucous membranes. Hence no operations must be undertaken on such patients unless absolutely urgent, even such a small matter as the extraction of a tooth having proved fatal.

The **Treatment** of hæmophilia should be directed more to correcting the constitutional defect than to pursuing the usual practice in dealing with hæmorrhage. The application or administration of hæmostatics, and substances which tend to promote coagulation and the formation of fibrin, should be resorted to. Calcium chloride, 1 ounce to ½ pint of water, given by enema, or a 1 per cent. solution applied locally, has been specially recommended of late, whilst fibrin ferment and cocaine have also been successfully employed. Position and pressure should be attended to, and in severe cases the actual cautery may be useful, or prolonged cold.

CHAPTER IX.

INJURIES AND DISEASES OF ARTERIES—ANEURISM—LIGATURE OF ARTERIES.

Injuries of Arteries.

Contusion of an artery is the result of violence applied directly to the vessel wall. The effects produced vary with the severity of the injury and with the previous condition of the arterial tunics. If atheroma or calcification exists, thrombosis often follows very slight injuries, and dry or senile gangrene may be the result; but in healthy arteries a good deal of violence is needed to produce such an effect, as their natural elasticity enables them to yield or slip aside, and thus the remote consequences are usually insignificant.

Rupture or Laceration may follow more severe blows or strains, pre-existing weakness or disease of the arterial wall predisposing to it. It occasionally results from attempts to reduce old-standing dislocations, or to break down intra-articular adhesions when the vessel has become fixed in an abnormal position. If the rupture is **partial**, the inner and middle coats are usually torn through, and by projecting into the lumen of the vessel constitute a valve which prevents the passage of blood, and leads to subsequent thrombosis and occlusion. In other cases, where the injury to the coats is slight, a thrombus may form, which leads to obliteration, or, if the lesion is limited to one side, the clot may become organized over that spot without interfering with the lumen of the vessel, though leaving an area of weakness from which an aneurism may subsequently develop. Again, when complicated with a septic wound, an ulcerative form of peri-arteritis may ensue, giving rise later on to secondary hæmorrhage. It is also stated that the outer coat is occasionally torn without injury to the tunica intima, and that an aneurism may result from a hernial protrusion of the latter coats through the wound; such an occurrence must be exceedingly rare. A dissecting aneurism (p. 249) may also under certain circumstances result from such an accident.

Complete Rupture of an artery may lead to but little hæmorrhage in a severe lacerated wound, such as is produced when a limb is torn off: the inner and middle coats give way at a higher level than the adventitia, and curl up within it, whilst the outer coat and sheath contract over them, and thus prevent bleeding. If, however, the artery is ruptured in a subcutaneous injury, such as a fracture or dislocation, extensive extravasation often ensues, constituting the condition badly termed a **Diffuse Traumatic Aneurism.** The objection to this name lies in the fact that there is no true sac wall as in an aneurism, the only boundary consisting of an ill-defined mass, partly coagulum, partly inflammatory exudation, and in part thickened and infiltrated tissues. A similar condition may ensue from a punctured wound dividing a vessel, where the track leading to it is valvular or becomes closed by clot or some external application.

Symptoms.—The patient usually feels a snap, as though something had given way, accompanied by a sudden pain, localized to the spot injured, and often shooting down the limb in the line of the vessel. These are succeeded by the following phenomena: (*a*) *Locally*, the formation of a diffuse, rapidly increasing swelling, the skin over which is at first normal, but soon becomes distended and bluish, and finally bright red and œdematous, when the tumour is threatening to give way. There is no increased local heat except in the later stages. There is usually distinct pulsation and some amount of bruit, synchronous with the heart's action, although these subsequently become less obvious. (*b*) *Distally*, diminished sensibility in the limb quickly follows, together with loss of pulsation in the vessels and a fall of temperature. It hangs more or less useless and flaccid, and in colour it is either somewhat white and blanched, or may become congested and œdematous if the extravasated blood presses upon the venous trunks. (*c*) *Generally*, the constitutional signs of hæmorrhage and shock manifest themselves in varying degree, according to the amount of blood lost and the character of the violence.

Results.—(1) The swelling may increase steadily in size from continued extravasation, until the skin becomes so distended as to *rupture* or slough, and then, if help is not at hand, the patient dies of hæmorrhage. Occasionally the bleeding continues into an internal cavity, or into the tissues of a limb, to such an extent as to cause death without any external loss of blood. (2) *Suppuration* may occur from auto-infection, or through the small valve-like wound, accompanied by the general signs of fever. The whole swelling becomes red, hot, œdematous, and excessively tender, looking like a large abscess. Rupture and external hæmorrhage will probably conclude the case if surgical assistance cannot be obtained. (3) The pressure of the extravasated blood upon the veins or on the arteries needed for the collateral circulation may determine *gangrene* of the extremity. (4) The process may become more or less *limited* after a time by coagulation occurring in the divided mouth of the vessel, which is thus occluded. Collateral circulation may be established, and thus the health and vitality of the limb are maintained, whilst the blood-clot is absorbed or organized.

The **Treatment** to be adopted must necessarily be the same as for a divided artery communicating with an open wound, viz., to cut down and tie both ends. To do this, the circulation must be temporarily arrested by an elastic band, a free incision made, and all coagula removed. The bleeding points are then sought for and tied, the tourniquet being if necessary relaxed to allow them to become evident. If the distal end cannot be found, it will not be wise to close the wound, but it should be stuffed with gauze, and allowed to granulate, a tourniquet being kept loosely about the limb ready to be tightened at any moment, if necessary. When suppuration is threatening, the same plan must be adopted, viz., free incision and tying the ends of the vessel if they can be found; but in cases where from the œdematous and unhealthy state of the surrounding parts this is impracticable, it will be necessary either to tie the main trunk on the cardiac side of the rupture, or to trust to the pressure of a graduated compress. If gangrene is imminent or if secondary hæmorrhage occurs, amputation is the only resource.

Penetrating Wounds of arteries, if completely dividing the vessel, are always followed by hæmorrhage, which, however, may be unable to escape if the wound in the skin is small or valvular, or if the opening is closed by blood-clot or dressing. Under these circumstances, the signs due to subcutaneous rupture of a vessel will be produced. The amount of the bleeding in open wounds varies according to the character, direction, and extent of the lesion, and with the size of the vessel. If a large artery is cleanly cut across, the bleeding will be copious, whilst from a small vessel it soon ceases, owing to the contraction and retraction of the coats. When an artery is buttonholed —*i.e.*, when a small segment of the wall is cut through—the hæmorrhage may be continuous and prolonged, since retraction cannot take place. The treatment of this condition consists in completing the division of the injured trunk, if it is a small one, thus allowing of contraction and retraction, or, if the vessel is of large size, in securing both ends by ligature, after dividing it.

If the wound is in the long axis of the vessel, there is but little gaping, and consequently but slight loss of blood; whilst if transverse or oblique, both contraction and retraction tend to increase the size of the opening, rendering it more nearly circular, and therefore the hæmorrhage in such cases may be considerable (Fig. 69).

If a small artery is divided close to its origin from a large main trunk, the blood escapes with a jet, the strength of which is proportionate to the blood-pressure in the main trunk, and not to the size of the vessel divided. In such a case the main trunk must be tied above and below the wound, and divided between the ligatures, and the distal end of the divided branch also secured.

In punctured wounds of arteries the size of the penetrating body is all important. A vessel may be traversed by a needle without hæmorrhage or any subsequent ill effect, but a larger puncture results in extravasation. If it ceases after a time, the blood-clot is absorbed, and the wound in the vessel closed by a cicatrix, which may yield later on to the blood-pressure, and give rise to a circumscribed aneurism. This occurrence is not unfrequently met with in the neighbourhood of the wrist as a result of glass wounds, involving the radial or ulnar trunks, and hence is not uncommon among window-cleaners or soda-water bottlers.

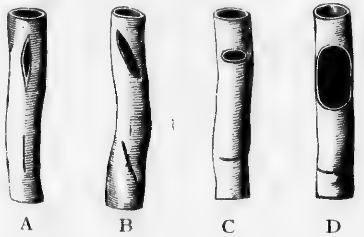


FIG. 69.—EFFECTS OF WOUNDS IN ARTERIAL WALL (DIAGRAMMATIC).

A, Longitudinal incision—but little gaping; B, oblique incision—greater opening, but not much; C, small transverse incision—wound gapes, becoming more nearly circular; D, large transverse incision—wide aperture, owing to retraction of arterial tunics.

Arterio-Venous Wounds are not so commonly met with in the present day as formerly, when venesection was in vogue. They follow penetrating wounds which involve an artery and vein lying in close contact, *e.g.*, at the bend of the elbow between the median basilic vein and the brachial artery, in the neck between the internal jugular and carotid, in the groin between the femoral vessels, and occasionally in the orbit. Two distinct conditions may result.

An **Aneurismal Varix** is produced by a direct communication between an artery and a vein, no dilated passage intervening between the vessels (Figs. 70, A and 71). The venous walls, unfitted to withstand arterial pressure, are by this means dilated and rendered varicose. A pulsating venous tumour is thus produced, the dilatation extending for a variable distance above and below the opening, and at each beat of the heart a loud whizzing sound can be heard, likened by some authors to that caused by an imprisoned bluebottle buzzing in a thin paper bag.

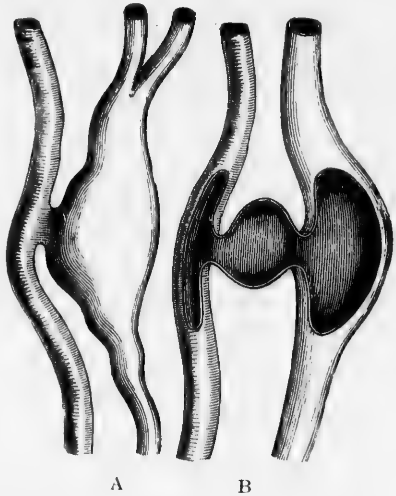


FIG. 70.—DIAGRAMS OF ANEURISMAL VARIX AND VARICOSE ANEURISM

Treatment.—As a rule, nothing is required beyond the application of an elastic bandage or support to prevent further enlargement. Should any inconvenience result from its presence, firm pressure may be applied over the artery above, over the sac, and also upon the vein below; and failing this, the whole mass may be removed, ligaturing both artery and vein above and below the communication. If the artery can be reached without interfering with the vein, it will suffice to tie the former above and below the abnormal opening. This operation should not be

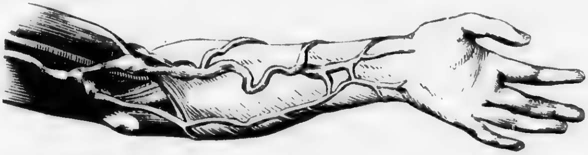


FIG. 71.—ANEURISMAL VARIX AT BEND OF ELBOW, DUE TO ABNORMAL COMMUNICATION BETWEEN MEDIAN BASILIC VEIN AND BRACHIAL ARTERY.

undertaken in the neck for the carotid-jugular varix unless absolutely essential. In the orbit electrolysis may be used with advantage.

A **Varicose Aneurism**, though brought about by the same cause, differs from the above in that an aneurismal sac exists between the artery and the dilated vein (Fig. 70, B). It is produced when the vessels are placed at some distance from each other, or when extravasation of blood has separated them. The aneurism is of the false type, its walls being composed entirely of newly-formed cicatricial tissue; it is never very large, but is almost certain to become diffuse. The physical signs are similar to those of aneurismal varix, except that the aneurism can be sometimes detected by palpation, whilst a soft bruit may be heard over it, and the distension of the veins is not quite so marked.

Surgical **Treatment** is always called for in these cases. If the aneurism is small, the dilated vein is tied above and below, the aneurismal sac extirpated, and the artery secured in a similar manner. Simple ligature of the artery above and below the abnormal communication will sometimes suffice, allowing the blood in the sac to coagulate; the veins will subsequently contract considerably, when the arterial blood-pressure is removed. In the less urgent cases digital pressure to the artery above the sac is occasionally successful.

Inflammation of Arteries.

Various forms of arteritis, involving all the coats of the vessel, are met with, which are usually named from the cause producing them—**Traumatic**, **Infective**, or **Embolic**. The terms *Endarteritis* and *Periarteritis* are used to distinguish inflammatory conditions which either start from the tunica intima, or reach the vessel from without; in both cases, however, the middle coat is also as a rule involved, and the process may even finally spread beyond it, so that the whole thickness of the arterial wall is attacked.

1. **Traumatic** or **Plastic Arteritis** arises as the result of some injury, such as total or partial division of the vessel, laceration, bruising, etc. The phenomena are merely those of repair, resulting in occlusion of the vessel, viz., congestion of and exudation into the vessel walls from the vasa vasorum, together with proliferation of the tunica intima; they have been already described at p. 215.

2. **Infective Arteritis** is a condition in which the arterial wall becomes invaded and softened by bacteria. It results most frequently from inflammation spreading inwards from the exterior (periarteritis), and is seen most commonly in connection with septic wounds and spreading ulceration. The vasa vasorum become dilated, and exudation of leucocytes occurs, as a result of the bacterial invasion; the peptonising power of the toxines

thereby produced leads to softening of the vessel walls, the fibres of which lose their cohesion with each other. Finally, they may be so impaired in their resisting power as to yield before the blood-pressure and cause hæmorrhage, unless thrombosis has previously sealed them. In the smaller arteries this is sometimes the case, but in those larger than the radial there is considerable danger of bleeding, especially if the irritation is confined to one side of the vessel. Secondary hæmorrhage from vessels tied in their continuity is usually due to this cause, and bleeding from phthisical cavities is also induced in this way, the vessels having lost the support of surrounding tissues, and being more or less dilated or aneurismal beforehand. Acute abscesses may erode the walls of an artery in a similar manner, as also malignant tumours. Septic ligatures may produce the same results, whilst the infective agent sometimes reaches the walls from within, as from an infective thrombus or embolus.

3. **Embolic Arteritis.**—When a vessel is blocked by a simple embolus, obliteration as a result of a simple plastic arteritis is the usual consequence. But if the embolus contain some irritating or infective material, as in a case of infective endocarditis or pyæmia, other results may follow, such as an abscess, or if the irritant is less intense, the process may stop short of suppuration, and yet an aneurism ensues from dilatation of the softened wall. The latter process is the most common cause of *spontaneous* aneurism in children.

4. **Acute Endarteritis** is met with rather as a pathological curiosity, than as a condition of any clinical import. It is usually associated with acute endocarditis, however produced, or may accompany some of the chronic forms described below. It is evidenced by the presence on the inner aspect of the vessel of more or less raised patches, somewhat pinkish and gelatinous in appearance, soft and elastic in consistency, and although the polish is lost, the endothelium is usually intact. It is found in the aorta, or in smaller vessels, especially near inflamed wounds.

5. **Chronic Endarteritis** is an exceedingly common affection, and the following forms may be described:

(*a*) **Simple Chronic Endarteritis**, resulting in **Atheroma.** This condition is constantly found in elderly people, but especially in drinkers and those who have suffered from chronic Bright's disease, gout, or syphilis; or it may arise from continual strain, and hence it is usually present in the great convexity of the aortic arch, at the spot where the impact of the blood-stream is most felt as it is ejected from the ventricle, or in places where the vessels pass over or around some bony projection, or at the bifurcation of a main artery, or where a large branch is given off, thus causing a sudden decrease in its lumen. It is rarely found in the smaller arteries, except those of the heart or brain.

The *pathological* phenomena observed are at first an infiltration of the deeper parts of the tunica intima with round cells (Fig. 72, *e*), which may organize into fibroid tissue, or may collect together and undergo degeneration (*f* and f_1). These patches are arranged longitudinally or around the mouths of large branches. The tunica media is more or less involved in the process, and the adventitia is often thickened externally. The patches look like pale yellowish spots, somewhat elevated from the inner surface, and irregular in outline; they are small at first, but increase in size, and coalesce one with another. In the early stages the vessel wall seems thicker and tougher than usual, but later on it becomes weaker and tends to stretch. Fatty degeneration of the newly-formed cells results in the exudation becoming fluid or cheesy, constituting the so-called 'atheromatous abscess,' although no true pus exists, the pultaceous material contained within consisting of fatty granules and débris, with oil globules and plates of cholesterine (Fig. 72, f_1). It may be absorbed entirely, leaving a weakened spot in the wall of the vessel, from which an aneurism may arise; or the tunica intima may give way over it, allowing the contents to be swept into the

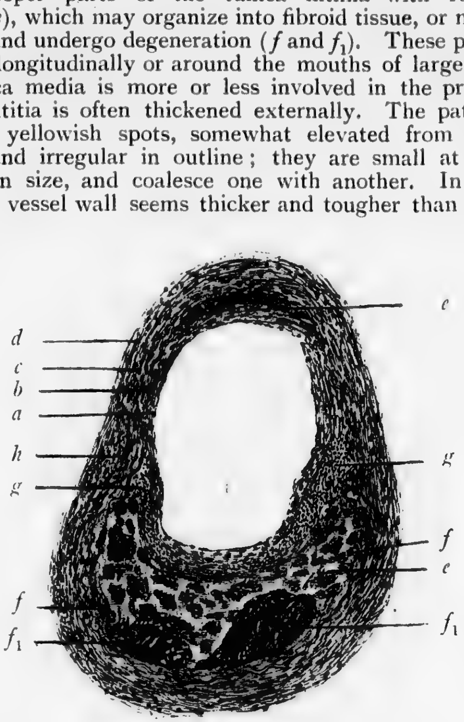


FIG. 72.—SECTION OF ATHEROMATOUS CEREBRAL ARTERY. (× 50.) (ZIEGLER.)

a, Intima considerably thickened; *b*, bounding elastic lamella of intima; *c*, media; *d*, adventitia; *e*, necrosed denucleated tissue with masses of fatty detritus; *f*, and f_1, detritus with cholesterine tablets; *g*, intima infiltrated with leucocytes; *h*, infiltration of adventitia with leucocytes.

general circulation, where it probably does no harm, and the raw surface left behind is known as an 'atheromatous ulcer.' The outer coat has by this time become sufficiently thick to resist the blood-pressure, and hence no immediate ill result follows the breach in the inner coats, although subsequently dilatation may take place, even though cicatrization of the ulcer has occurred. Again, the blood may find its way through the opening into the substance of the wall and strip up the inner from the outer layers, constituting a 'dissecting aneurism'; or a localised thrombosis may be determined, causing occlusion of the vessel.

Not uncommonly the cheesy contents of the abscess are more or less inspissated, and later on infiltrated with lime salts, resulting in the formation of calcareous plates, which are either covered with endothelium, or exposed to the blood-stream, and hence may either cause thrombosis, or may become detached and constitute an embolus, or the blood may get in under the plate and form a dissecting aneurism.

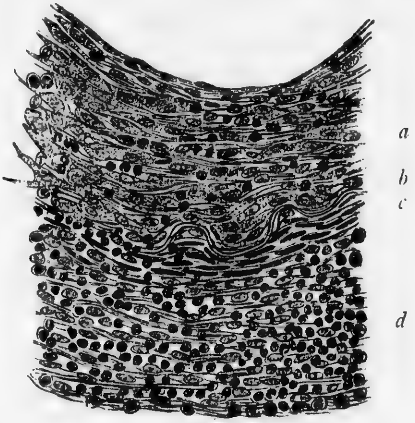


FIG. 73.—SYPHILITIC ARTERITIS. (× 150.) (ZIEGLER.)

a, Intima greatly thickened by newly-formed fibro-cellular tissue; *b*, fenestrated elastic lamina of Henle; *c*, muscle fibres of media, infiltrated towards the left; *d*, adventitia thickened by cell infiltration and hyperplasia.

A condition of endarteritis evidenced by proliferation of the tunica intima is always met with in chronically inflamed tissues, as also in diabetes; such does not, however, run on to atheroma.

(*b*) **Chronic Syphilitic Endarteritis** is commonly met with in patients in the tertiary stage of the disease, and is characterized by an overgrowth of the tunica intima (Fig. 73 *a*), which is usually limited by Henle's elastic lamina (*b*), but is sometimes associated with infiltration of the media (*c*), and much more so of the adventitia (*d*). The change occurs in the smaller arteries, especially those of the brain or kidneys, or in the neighbourhood of gummata, and but rarely in the larger vessels, although a considerable percentage of those affected with internal aneurism have suffered from syphilis. It differs from simple atheroma in the greater amount of the cell proliferation present, and in the tendency to contraction of the arterial wall, with occlusion of the vessel, rather than to weakening and dilatation. When involving the cerebral arteries, various forms of monoplegia, or even hemiplegia, may result.

(*c*) It is still more or less an open question whether the so-called **Endarteritis obliterans** or **proliferans** is truly syphilitic or not. In some cases a syphilitic history has been present, but in other marked instances it has been entirely absent. The arteries become gradually obliterated in persons apparently sound in health, and as a result the peripheral parts become either anæmic and waxy, or congested, and even gangrenous. The tunica intima is converted into a thickened and vascular mass, which narrows and finally occludes the lumen. The process is often associated with considerable local pain.

(*d*) **Chronic Tubercular Endarteritis** is met with as a proliferation of the tunica intima, with or without thickening of the adventitia, in all places in which tubercle is actively developing; in fact, tubercles are usually formed in connection with the smaller arterioles, which can be readily demonstrated in the pia mater, and as the mass grows the vessel is slowly occluded and replaced by the typical anatomical structure of the miliary tubercle. The tubercular endarteritis may, however, spread widely beyond the focus of the mischief, and in almost any portion of pulpy granulation tissue this change can be seen.

The vessels may also be attacked by tubercular processes from without, and if caseation is present, the walls may be eroded, and tubercular material thus find an entrance into the circulation, causing embolic obstruction and tubercular disease elsewhere.

Degeneration of Arteries.

Fatty Degeneration may occur independently of atheroma, involving merely the tunica intima, and manifesting itself in small patches, yellowish in colour and stellate in shape. As a rule, it is of but little significance; but occasionally the infiltration is deeper, and the tunica intima gives way, causing the so-called *fatty erosion*, and then an aneurism, possibly of the dissecting type, may arise. The most usual seat of this trouble is the aorta.

Calcareous Degeneration (Fig. 74) is chiefly met with as a primary phenomenon in the smaller arteries of the extremities. It occurs in elderly people at the same time of life as the calcification of cartilages, etc., and commences by the deposit of lime salts in the muscular fibres of the tunica media, tending to form calcareous rings which transform the elastic expansile vessels into rigid tubes like gas-pipes, through which a minimal supply of blood can alone pass, the amount of which cannot be regulated as in a healthy artery.

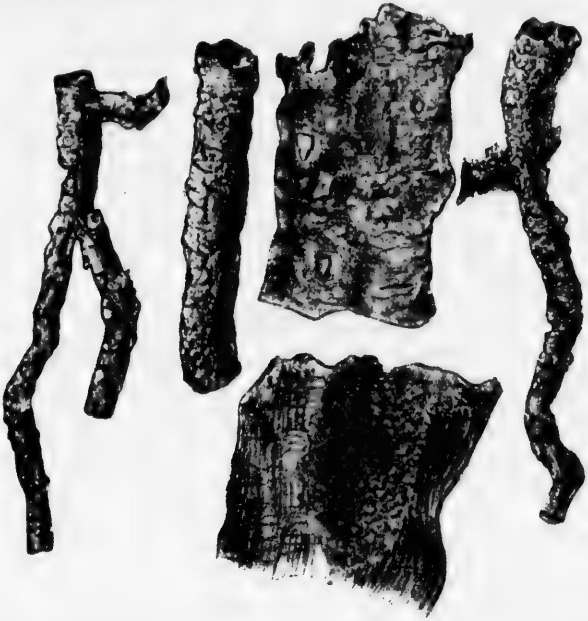


Fig. 74.—Rigid Calcareous Arteries. (From College of Surgeons' Museum.)

The limb in consequence passes into a condition of chronic anæmia and impaired nutrition, resulting in coldness of the feet or hands, cramps and spasms of muscles, sensations of pins and needles, etc. The endothelium is not removed except in the later stages, and then thrombosis may be produced, or a similar result may arise from the lodgment of an embolus from above. Senile gangrene is a not uncommon termination of such arterial changes. From the general rigidity of the vessel, and the method of deposit of the lime-salts, it follows that aneurism is not commonly produced, and in fact spontaneous aneurism of the vessels involved by this form of degeneration is amongst the rarities of surgery.

Amyloid Degeneration of the viscera commences in the arterial walls, but is described elsewhere (p. 46).

The Effects of Arterial Inflammation and Degeneration are both local and peripheral. *Locally*, **Thrombosis** is likely to occur whenever the lining endothelium is removed and a raw surface exposed, upon which fibrin can collect. Under this fibrinous coating repair is often accomplished without further complication; but if the blood-stream is retarded, or the lumen of the tube narrowed, complete thrombosis is likely to follow, the clot extending some distance up or down the vessel, or even from a branch into the main trunk, which may be occluded by this means. **Aneurism** is also a result of any weakening of the arterial tunics. **Obliteration** of the artery may follow, both as a result of thrombosis, and from excessive proliferation of the tunica intima (as in syphilitic or tubercular disease), or from gradually increasing pressure from without. Lastly, **Spontaneous Rupture** is another local effect occasionally met with.

Peripherally, defective blood-supply and consequent **lowered vitality** are the most marked results of arterial disease, leading to various forms of ulceration and gangrene. Thus, senile gangrene results from calcareous changes in the arteries, fatty degeneration of the heart may follow atheromatous changes in the coronary arteries, whilst softening of the brain may ensue from various affections of the cerebral vessels. Similar results may also arise from **emboli** detached from areas of local disease.

Aneurism.

An **Aneurism** is a tumour filled with blood communicating with the interior of an artery, and due to dilatation of part or the whole of the vessel walls.

Causes.—Aneurisms have been divided into two great classes, viz., the spontaneous and the traumatic, and a necessary distinction has been made between them on account of the fact that in the former the coats of the artery are primarily diseased, whereas in the latter they may be previously healthy. However, it must not be forgotten that persons with diseased arteries are just as liable to injury, and even more so, than those with healthy vessels, and thus no strict line of separation can be drawn between the two forms. The causes of aneurism may be conveniently grouped under two headings:

1. **Changes in the Vessel Walls**, by which their resistance to the intravascular pressure is diminished. Many forms of *disease*, whether starting from within or without, predispose to aneurismal dilatation, such as atheroma, or those changes due to syphilis or

gout, especially if occurring in men about middle life (thirty to fifty years of age), in whom, although the arterial tunics may be weakened, the power of the heart and the resulting blood-pressure is by no means diminished. Calcification, on the other hand, is antagonistic to aneurismal dilatation. Any form of *injury*, either a direct blow, a penetrating wound, or a severe strain, may so interfere with the integrity of the vascular coats as to result in aneurism, and, indeed, any cicatrix involving an arterial wall must be looked on as a weak spot predisposing to dilatation. The lodgment of an *embolus* in the smaller arteries is stated to be one of the most common causes of the spontaneous dilatation of these vessels, especially in the brain and extremities of young people.

2. **Increase in the Blood-Pressure** is another essential to the formation of aneurisms, and the most common origin of this is heavy *strain* or *exertion*, which leads to irregular excitement and increased action of the heart. Steady laborious employment, such as is seen amongst artisans and mechanics, or regular exercise, does not appear to particularly predispose to this condition; but irregular intermittent efforts, in which for the time being every power is strained to its utmost, are very liable to determine its occurrence. A day's exertion in the hunting or shooting field by an elderly man, accustomed to sedentary occupations, is very likely to produce some serious vascular lesion, such as aneurism, apoplexy, etc. Hence aneurisms are more frequently seen amongst men than in women, in the proportion of seven to one; whilst they are much more common among the dwellers in Northern climates than in the more lethargic and ease-loving inhabitants of the South. The energy and activity of the Anglo-Saxon race especially predispose them to this disease.

Structure and Formation of an Aneurism.—Great importance has been laid upon the way in which an aneurism arises, and as to whether or not the different coats of the vessel are represented in its walls; but the matter is really of little moment compared with the size and shape of the tumour. Sometimes it arises from the yielding of the healthy or diseased walls, whilst sometimes there is a lesion or loss of the tunica adventitia; and, again, other cases commence by a removal of the tunica intima or part of the media. Formerly much stress was placed on the terms *true* and *false*, as applied to aneurisms, the term 'true' meaning that all the coats of the vessel were present, whilst the 'false' were those in which the sac wall comprised little or none of the original arterial tunics. This distinction is of comparatively little value, since no aneurism which has attained to any size is in reality true. The *sac* consists more or less evidently of a distension of all or part of the original walls of the vessel whilst it is small; but as the aneurism increases, the original structure is lost sight of, and, indeed, is replaced by a mass of newly-formed fibrous tissue, due to a condensation and matting together of the surrounding structures, with or without an internal lining of laminated fibrin deposited on parts where the endothelium of the tunica intima has disappeared. The *contents* of the sac vary according to the age and size of the aneurism. Whilst still small and with a complete endothelial lining, it merely contains fluid blood, the amount of which varies with each beat of the heart; but as the tumour grows, the whole or part of the interior becomes lined with a deposit of fibrin, upon which, again, other layers form, until possibly in rare cases the whole cavity is occluded, and a spontaneous cure results. The oldest laminæ lie next to the sac wall, and are dry and yellowish-white in colour (the so-called *active clot* of Broca); those more recently deposited are softer and more reddish, whilst that last formed is merely like ordinary blood coagulum (the *passive clot* of Broca). No single lamina covers the whole area, but they are arranged layer over layer in such a manner that the oldest, and necessarily the smallest laminæ are most external.

Three chief **varieties** of aneurism have been described: the fusiform, sacculated, and dissecting.

1. The **Fusiform Aneurism** (Fig. 75, A) is one in which the whole lumen of the vessel is more or less equally expanded, so that the swelling is tubular in character. It is due rather to a general increase of blood-pressure, or to a widely extended disease of the arterial walls, than to any localized lesion or injury, and hence is more commonly met with in the larger internal vessels than in those of the extremities. When it does occur in the latter situation, it gives the case a much more serious aspect. Not only is the vessel dilated, but the tube is elongated, and considerable structural changes are present in the walls. The tunica intima is usually represented throughout the whole extent of the sac, but is thickened and atheromatous in patches, the margins and surfaces of calcareous plates being indicated by flocculi of fibrin, which are attached to them, although no regular laminated deposit is present. The tunica media is stretched, atrophied, and practically absent, whilst the adventitia is much thickened by inflammatory new formation, and by incorporation with the surrounding tissues. The progress of fusiform aneurisms is generally slow, so that in some situations, *e.g.*, the thorax, they may attain enormous dimensions, and cause grave symptoms by their pressure. A natural cure is almost impossible, and hence, if unchecked by treatment, a fatal termination may be caused by rupture or by implication of important neighbouring structures. Frequently some portion of the aneurismal wall yields more than another, and thus to the fusiform swelling is superadded a localized sacculation, which by its rapid increase in size may quickly destroy life.

2. A **Sacculated Aneurism** (Fig. 75, B) is due to the yielding of some weak spot in the vessel wall which does not involve the

whole circumference, or, as just mentioned, it may spring from a fusiform aneurism. It communicates with the interior of the artery by an opening of variable size. All traumatic aneurisms are of this type, whether they are due to the yielding of a cicatrix, or to the partial division of the coats of the vessel, and hence they are most commonly met with in those of the extremities. It is possible that in some specimens all the original vascular tunics may be present, but such an occurrence must be extremely rare. Generally one can trace the inner and middle coats to the mouth of the saccule, and there they are suddenly lost, the wall being constituted by a mass of fibro-cicatricial tissue, upon which laminated fibrin readily forms, thus increasing its thickness and power of resistance. Their progress is, however, much more rapid than that of the fusiform, and they generally rupture or become diffuse, although occasionally a natural cure results. The blood, as it enters the sac, impinges against the wall furthest removed from the heart, and thence eddies back in circles, coagulation being thereby favoured owing to the retardation of the blood-stream.

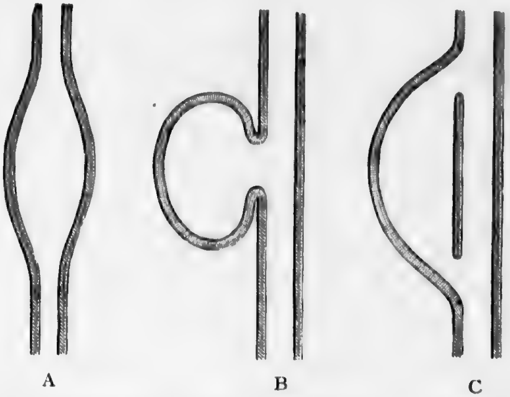


FIG. 75.—DIAGRAMS OF FUSIFORM, SACCULATED, AND DISSECTING ANEURISMS.

In the first the walls are expanded, but more or less normal in texture; in the sacculated, the normal structure of the arterial wall ceases abruptly at the commencement of the saccule; in the dissecting, the arterial wall is split into two lamellæ.

3. A **Dissecting Aneurism** (Fig. 75, C) is one in which the blood forms a cavity within the wall of the vessel by stripping up the inner from the outer half, the line of cleavage being within the middle coat, half going with the adventitia, half with the intima.

As a rule, it is the result of extensively diffused atheroma which has weakened the structure of the tunica media, so that should once the blood find an entrance through an atheromatous ulcer into this layer, it is easily able to separate the inner from the outer half. It is usually met with in the arch of the aorta. The blood thus driven into a cul-de-sac may remain limited to this cavity for some time, or it may find its way outwards through the adventitia, and become ultimately diffused externally, or it may find its way back through another atheromatous spot into the interior of the vessel. The condition cannot be recognised *ante-mortem*.

Symptoms and Signs of a Circumscribed Aneurism.—These may be divided into two groups: the intrinsic and extrinsic.

Intrinsic Signs.—A tumour is present in the course of a vessel, which pulsates synchronously with the heart's beat. The pulsations are distensile or expansile in character, *i.e.*, the whole tumour increases in size at each systole of the heart, and that evenly in all directions, so that if the tumour is lightly grasped in any position the fingers are separated. If the supplying vessel is compressed on the proximal side, the pulsation ceases, and the tumour diminishes in size and becomes softer. This is more marked in fusiform than in sacculated aneurisms. The application of pressure to the sac itself whilst the afferent trunk is compressed above will still further diminish its size. On removing the pressure, the swelling regains its old dimensions in a certain definite number of beats, usually not more than two or three. Pressure on the distal side of the sac makes it more tense and the pulsation more marked, unless such compression is very prolonged. On auscultating the tumour, a bruit of variable character may be heard. Usually it is loud, harsh, and systolic, but sometimes quiet and musical. It is occasionally double in some forms of sacculated aneurism, and in the aorta where regurgitation through the aortic valves is also present. The bruit is loudest and most rasping in the fusiform variety, and may be absent in the sacculated form, where the mouth is small and the cavity nearly full of clot. Great distension of the sac is unfavourable to the production of the bruit.

The **Extrinsic Signs** of aneurism are those occurring in neighbouring or distal structures from its constantly increasing size and **pressure**, and the interference produced by it with the circulation. The *pulse* in the vessels *below* is diminished and delayed, being smaller than in healthy conditions, partly from the obstruction experienced, but also in some cases from the pressure of the sac upon the trunk above or below the tumour. The dicrotic notch is usually absent. The smaller vessels engaged in establishing collateral circulation may be compressed, and thus the vitality of the limb considerably impaired. Pressure on the accompanying vein or *veins* results in diminution in their calibre, and possibly a localized thrombosis, together with congestion and œdema distally, whilst gangrene may be the final outcome if the case is not efficiently treated. Compression of *nerves* occasions neuralgia, spasm, and paralysis. *Muscles* are displaced, expanded, and attenuated; *bones* may be eroded, as evidenced by a deep, constant boring pain, and even spontaneous fracture may ensue; whilst *joints* are encroached upon and disorganized. *Tubes*, such as the trachea or œsophagus, are often injuriously constricted and laid open by ulceration. It is an interesting fact to note that resisting tissues, such as bone, are much more likely to be eroded than are elastic, yielding structures, such as cartilage, and in cases where the vertebral column is encroached upon by an abdominal or thoracic aneurism, the bones always manifest greater destructive changes than the invertebral discs.

The increased difficulty in propelling the blood through the sac usually induces a certain amount of compensatory hypertrophy of the *heart*. Occasionally *emboli* consisting of fragments of laminated fibrin may become detached, and either lead to a spontaneous cure, or to gangrene of the parts supplied by the vessel, or to death of the individual if the brain is involved. *Gangrene* may also be induced as a result of the diminished blood supply to peripheral parts, especially if associated with interference with the venous return. It is usually of the dry type if involving merely one or two fingers or toes; but when attacking more fleshy parts, or if due to venous congestion, it becomes moist in character.

The **Differential Diagnosis** of a circumscribed aneurism is not difficult, as a rule, if due weight is given to the above symptoms and signs, but the following conditions may simulate it somewhat closely: 1. A *tumour* or *chronic abscess* situated near an artery, and deriving *transmitted pulsation* from it, is recognised by the impulse being merely heaving in character, and not expansile; by the pulsation ceasing entirely if the tumour is lifted from the vessel, or allowed to fall away from it by assuming a suitable position; by the size of the tumour not diminishing if the pulsation is stopped by pressure on the vessel above; and by the fact that after stoppage of the pulsation the first beat is equal to the subsequent ones, whereas in an aneurism it almost always requires more than one beat to re-establish the strength and force of the impulse. Moreover, the pulse below is not affected in the same way or to the same extent as when an aneurism is present. 2. A *pulsating sarcoma* or *nævus* is known by being rarely limited exactly to the line of the artery, pulsation being present in situations where an aneurismal dilatation could not be felt, and being less forcible and regular in its character. The consistency of the swelling is more variable, and pressure over the afferent trunk does not diminish its size to any marked extent. Moreover, a sarcoma is usually more adherent to the deeper structures, and its limits are not so accurately defined. 3. The pain caused by an aneurism may cause it to be mistaken for *rheumatism or neuralgia* (*e.g.*, for sciatica in popliteal aneurism), and in every case of obstinate pain of this kind the arteries should always be carefully examined with the intention of eliminating such a possible cause of the trouble.

Natural Terminations and Results. — 1. **Spontaneous Cure,** though of unusual occurrence, may arise from a variety of circumstances, and is a well recognised phenomenon. It is only met with in sacculated aneurisms. (*a*) It may be due to the gradual deposit of fibrin within the sac, which not only limits the expansion and extension of the aneurism, but may actually increase to such an extent as to cause obliteration of its cavity. Such a termination can only occur in sacculated aneurisms with small mouths, and that mainly in vessels of the second magnitude, hardly ever in the aorta or larger trunks, the impetus of the blood stream being too great to permit of the necessary deposit of fibrin. (*b*) It may arise as the result of the sudden coagulation of all the blood in the sac from the stoppage of the circulation, owing to the lodgment of an embolus either at the mouth of the aneurism or in the distal part of the trunk. (*c*) Again, if the sac becomes inflamed, consolidation may result with or without suppuration, although the latter process, as will be seen anon, is attended with serious danger to life and limb. (*d*) Finally, a sacculated aneurism may become so large as to compress the main vessel, either going to or coming from it, and thus bring about its own cure. In the non-inflammatory conditions the sac becomes more and more firm, the pulsation less forcible and distinct, the bruit diminishes, and finally consolidation is effected, a firm fibroid tumour alone remaining, which gradually shrinks, whilst the collateral circulation is opened up so as to supply the limb below.

It is by no means always easy to recognise the fibroid mass resulting from the spontaneous consolidation of an aneurism, and to effect a diagnosis the history has mainly to be depended on. The existence of a tumour in the line of an artery, the probable occlusion of the main trunk, and the fact that the circulation is carried on by means of collateral branches, are the chief points which can be ascertained by a physical examination.

2. **Diffusion and Rupture** result from yielding of the walls of a sacculated aneurism, perhaps as an outcome of some mechanical injury, or in the case of internal aneurisms from simple overdistension.

When an internal aneurism suddenly gives way, the patient usually experiences a sensation of pain in the part, and becomes pale, cold, and faint, possibly dying within a few minutes, or at most hours, or there may be a sudden gush of blood from the mouth if the trachea or œsophagus has been opened. Sometimes, however, internal aneurisms leak slowly, and the final stage lasts some days.

When an external aneurism yields, it may do so slowly or quickly. If the blood becomes effused *slowly* (constituting what is sometimes called a *leaking aneurism*), the tumour gradually increases in size, and its outline becomes less clearly limited; the pulsation diminishes in force and distinctness, and the signs of pressure upon the veins or nerves become more urgent, until, perhaps, gangrene supervenes, or after a time the process may cease, and even a spontaneous cure result. If the aneurism ruptures *suddenly*, the patient experiences severe pain in the part, which becomes tense, swollen, and brawny; all pulsation ceases both in the aneurism and below it, and gangrene of the limb supervenes or even death from syncope, arising from the amount of blood extravasated, either externally if the skin gives way, or into the tissues and under the fasciæ. Suppuration may also occur in these cases, the skin becoming red and inflamed, and finally external rupture may follow. The recognition of diffuse aneurisms is by no means simple, especially when they become inflamed, and the most careful attention to the history and to the facts to be made out by digital examination can alone determine the nature of the case.

3. **Suppuration** of the sac is an exceedingly serious, but by no means a common, complication of aneurism. It may arise in the following ways: (*a*) After ligature of the main vessel above, especially when the wound becomes septic, and there is a good deal of loose cellular tissue around the sac, as in the axilla; (*b*) after diffusion, partial or complete, of an aneurism, where the cavity is filled with clot, and there is great pressure and tension upon surrounding parts. Auto-infection or the presence of an infective embolus may finally determine the suppurative process. The tumour shows signs of inflammation, being hot, red, painful, and swollen, and the skin over it may pit on pressure; whilst fever and general constitutional disturbance are also present. Sooner or later, if left to itself, the tumour points at one spot and bursts, giving exit to a mixture of blood clot, pus, and a greater or less amount of bright red blood. The patient either dies immediately from syncope, or a little later from secondary hæmorrhage and septic poisoning. Occasionally, but very rarely, the afferent trunk becomes plugged by a thrombus, and spontaneous cure may thereby be induced.

Treatment of Aneurisms.

I. **General Treatment** may either be employed as an accessory to surgical treatment, or must be depended on entirely in cases where local means are impracticable or contra-indicated, such as in internal aneurisms, and is then to be looked on rather as palliative in nature than curative. The constitutional habit of the patient must be carefully investigated, since aneurisms are associated either with plethora or with an enfeebled and cachectic state of the system.

In *plethoric* individuals, where the disease tends to run a rapid course, absolute rest, both mental and physical, must be enjoined, with the removal of all sources of irritation and worry. The bowels must be freely opened by a calomel purge at the commencement of treatment, and watery stools should be subsequently induced by 20 grain doses of pulv. jalapæ co. two or three times a week, so as to increase the plasticity of the blood. The force of the heart's impulse may be diminished by the use of aconite, and even venesection may be useful and advisable where it is very excessive. Iodide of potassium is the drug upon which most reliance is placed, both for reducing blood-pressure and in cases where a syphilitic history is present. The diet must be judiciously and gradually diminished, all stimulating articles being eliminated, and only highly nutritious material allowed, and that mainly of the nitrogenous type, with as little fluid as possible. Various special methods, *e.g.*, Tufnell's, Valsalva's, etc., have been recommended, but as a rule it will suffice to limit the dietary as much as is in conformity with the patient's comfort and well-being, and not to allow more than about a pint of fluid in the day.

In *weakly individuals*, whilst enjoining strictly a recumbent posture, the surgeon should prescribe iron and a somewhat more liberal diet, in order to improve the quality and plasticity of the blood.

II. The **Surgical Treatment** of aneurisms has varied much at different times and in the hands of different surgeons; the condition, situation, and surroundings of the tumour will also materially influence the line of treatment to be adopted.

Whichever of the plans described below is chosen in any particular case, the general health must be carefully attended to, and the condition of internal organs fully investigated beforehand, as great harm may follow injudicious interference, if internal aneurisms also co-exist. The following are the main methods made use of in the treatment of aneurisms:

1. **Compression.**—Although compression had been adopted before Hunter introduced ligature of the main vessel in the treatment of aneurisms, its value had been lost sight of for a time, and for its re-introduction we are mainly indebted to the activity and skill of the Dublin surgeons, who proved that in well-selected cases a cure can be effected by its means as comfortably, safely, and successfully as by the ligature.

The compression may be continuous or intermittent. If *intermittent*, pressure over the main vessel leading to the aneurism is kept up by means of the fingers (digital compression) or by mechanical appliances for as long a period as the patient can bear, which as a rule does not exceed thirty minutes, if there is any nerve in the immediate neighbourhood liable to be also pressed upon. There seems to be no necessity to completely arrest the flow of blood through the sac, so long as the blood-pressure is sufficiently diminished to permit of coagulation within it. *Continuous* pressure can, as a rule, only be maintained under an anæsthetic, and in such cases the circulation through the sac is entirely stopped, so as to allow not only of its contraction, but also of the rapid coagulation in some cases of its contents, especially if some amount of clot is already present, as in the majority of the sacculated aneurisms of the extremities. Such pressure may be effected by the fingers of relays of dressers, taking shifts of ten to fifteen minutes at a time; but inasmuch as this is excessively tiring and difficult to maintain efficiently, arrangements should be made whereby some weight, such as a conical shot-bag, rests upon the thumb or finger employed, thereby relieving muscular strain. Tourniquets may be similarly employed, but are less satisfactory, since they require more skilful and accurate adaptation, and are liable not only to slip out of place, but also to bruise the coats of the vessel. The best appliance of this nature is probably Petit's tourniquet (Fig. 68). Esmarch's elastic bandage has also been used with success, principally for aneurisms of the lower extremities, notably the popliteal. The limb is first elevated for some moments, and then the elastic bandage applied from the toes to the upper part of the thigh, passing loosely over the aneurism. An indiarubber tourniquet is then placed round the upper part of the thigh, so as to arrest the circulation completely. The limb may in this way be left with impunity almost bloodless for an hour and a half (*Reid's method*).

As to the *value* of compression—although in suitable cases it certainly has been successful, and should be given a trial before proceeding to ligature, yet it is undesirable to persevere with it for too long, lest the collateral circulation is increased to an undesirable extent, and thus the success of the subsequent operation interfered with. Especially is this the case in plethoric individuals with high arterial tension. On the other hand, in feeble, weakly patients, where gangrene of the limb might be anticipated, the opening up of the collateral circulation by compression, even it the aneurism is not thereby cured, may prove advantageous to the success of the subsequent ligature. Necessarily, in all cases, the part of the skin to which pressure is applied must be carefully protected from local irritation by the use of dry aseptic dusting-powders, by shaving and removal of hairs, and by seeing that the surface of any pad employed is perfectly smooth, and the skin not wrinkled beneath it.

2. **Ligature** of the main vessel leading to or coming from the

aneurismal sac must next be considered. The oldest procedure, the **Operation of Antyllus**, consisting in laying open the sac, turning out the clots, and securing the vessels above and below (Fig. 76, A). Performed, as it was originally, without anæsthetics or antiseptics, it was naturally attended with great mortality; but in the present day it has been resuscitated with some modifications, and used with great success (*vide* Extirpation, p. 258).

By **Anel's Method** (Fig. 76, B), the artery was tied just above the sac on the cardiac side; but this also proved dangerous, since secondary hæmorrhage frequently resulted, either from the cavity of the aneurism becoming inflamed owing to sepsis, or from injury to the sac during the operation, or from the arterial wall, which is in all probability diseased, yielding at the site of ligature from septic periarteritis.

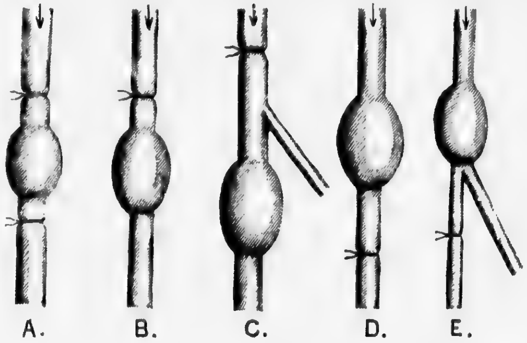


Fig. 76.—Methods of applying Ligatures for Aneurisms.

A, Method of Antyllus; B, Anel's operation; C, the Hunterian operation; D, Brasdor's operation; E, Wardrop's method.

Hunter's Operation (Fig. 76, C), which consists of ligature of the main vessel on the cardiac side at some distance from the aneurism, was first performed by him in 1785. The object to be attained is not to absolutely cut off the blood-supply to the sac, but to allow the blood to enter it with a greatly diminished impulse, and in small amount, at first, thus permitting of the contraction of the sac wall, and of the gradual deposit of fibrinous clot within it. The sac thus becomes consolidated, and finally transformed into a mass of firm fibroid tissue. It is most likely to succeed in those cases where the aneurism is well defined and not large enough to exercise injurious pressure on surrounding parts, whilst it is also desirable that no branch of large size should intervene between the point of ligature and the sac. It should be ascertained, if possible, that the vessel is in a healthy condition at the spot where the ligature is to be applied. The operation is *contra-indicated* (1) in cases where serious cardiac disease co-exists, or where an internal aneurism is also present, suggesting that the whole arterial system is affected, and rendering any sudden increase of the blood-pressure, as by occlusion of a main vessel, undesirable; (2) where pressure over the vessel does not control the circulation through the sac; (3) where the peripheral vessels are extensively calcified; (4) where gangrene of the limb is threatening or present; or (5) where bones or joints have been seriously involved.

Distal Ligature is mainly practised for aneurisms situated in positions where it is impracticable to deal with the artery on the cardiac side of the sac, such as the innominate, lower part of the carotid, or first part of the subclavian. **Brasdor's Operation** consists in tying the main trunk beyond the sac, so as to totally cut off the circulation through it (Fig. 76, D). In **Wardrop's Operation** a ligature is placed on one or more of the distal branches (Fig. 76, E). In the former the sac often partially collapses at once, and thus allows of the deposit of fibrin; but it has been suggested that the cure is usually effected by an extension of the act of coagulation from the site of ligature to the sac. In the latter proceeding, where the circulation is only partially controlled, the diminution of the size of the aneurism goes on much more slowly, and the chances of the deposition of clot in the sac are correspondingly lessened.

It is not unusual, after the application of a ligature to a main artery for aneurism, to observe a **return of pulsation in the sac.** In the majority of cases this only continues for a short time, and is by no means an unfavourable sign, indicating the re-establishment of the collateral circulation; but if it commences a week or ten days after the operation, it is more likely to persist, and will then indicate that the ligation of the vessel has failed in accomplishing the object for which it was adopted. It is most frequently seen in cases where the main vessel has been tied at some distance from the sac, as in the superficial femoral for popliteal aneurism, and where one or more large and important collateral branches carry blood into the artery below the ligature or directly into the sac. The most favourable conditions for gradual consolidation are those in which the blood reaches the aneurism from below free from impulse. A few cases are recorded in which the artery has become pervious at the seat of ligature after some months, or a fresh aneurism developed at a spot contiguous to the original tumour. The early recurrence of pulsation needs no *treatment* in most instances, since it disappears spontaneously; but when it comes on at a later stage, it demands serious attention. Rest, elevation of the limb and judicious pressure over the trunk above the site of ligature, should first be tried. This failing, the following courses are open: (*a*) The artery may be again tied either at a point nearer the sac when feasible, or further away from it; (*b*) where the aneurism can be reached, it may be cut down on and dissected out, the best course to adopt if it be practicable; or (*c*) amputation just above the aneurism may be called for as a last resource, where the tumour is rapidly increasing or threatening to become diffuse, or when gangrene is impending.

3. **Complete Extirpation** of the aneurismal sac, with or without laying it open, may be looked on as the best and most satisfactory method, if practicable. It is thus dealt with as a tumour, although, owing to the adhesions always present, complete separation of the wall from surrounding parts is often extremely difficult. The limb is previously exsanguinated by elevation, and in suitable cases the aneurism is removed without opening it, and the vessel secured by ligature above and below, as also any branches which may open into the sac. When, however, a large saccule obscures the main trunk, it may be necessary to open it before attempting its extirpation. Not unfrequently the vein will be encroached on in this dissection, and it may have to be removed; as a rule, no bad result follows, owing probably to its lumen having been already diminished by the pressure of the sac. This method is chiefly applicable to small aneurisms of the peripheral vessels, and, indeed, in the majority of such cases no other plan need be considered; surgeons are now, however, extending its use to a similar condition of the larger trunks. It is also attempted as an alternative to amputation for recurrent, diffused, and suppurating aneurisms. The results of this operation which have been recently recorded are most encouraging: primary union of the wound is often obtained, and hence the length of treatment is curtailed; all chances of recurrence are removed; statistics show that there is less chance either of gangrene or secondary hæmorrhage, and, if the aneurism is situated in the flexure of a limb, there is less subsequent interference with its mobility, since no puckered cicatrix or fibroid tumour remains as in other methods of treatment.

4. Various measures may be grouped together under this heading, where neither compression, extirpation, nor ligature is advisable or feasible.

Electrolysis has been occasionally employed during the last sixty years in dealing with thoracic aneurisms when a saccule has developed in an accessible position. The clot thus formed is extremely soft and liable to break up, and the results have not been very satisfactory. For details of the methods of employing electrolysis, see p. 302.

Injection of the Sac with Coagulating Fluids—*e.g.*, perchloride of iron—has not been extensively tried on account of the great risk of embolism, and of inflammation followed by suppuration. Its use could only be justifiable in cases where there exists a slowly growing saccule with a small mouth; but it is not easy to make certain of the presence of such conditions.

The Introduction of Foreign Bodies into the Sac (*Moore's Method*) has not been followed by much success, although one case of abdominal aneurism (Loreta's) seems to have derived temporary benefit from it. Steel wire is usually employed; it is firmly wound round a cotton reel to give it a spiral coil, and inserted into the sac through a very fine cannula. Varying lengths from 10 feet to 26 yards have been introduced.

Acupuncture has been occasionally tried for many years, but without much advantage being derived therefrom. Recently, however, **Macewen** has again drawn attention to the value of the method, and suggested some modifications in the technique. He passes fine needles into the interior of the sac, and with them scratches the posterior wall so as to cause a certain amount of inflammatory thickening, and thus determine a deposit of fibrin. Whether the benefit is actually due to this needling is a little doubtful, since the walls of an aneurismal sac are usually sufficiently roughened already, and it is quite possible that any advantage derived from the proceeding is due to the introduction of a foreign body and the deposit thereon of clot.

The **Hypodermic Injection of Ergotin** into the cellular tissue surrounding an aneurism has been suggested by Langenbeck as a means of cure, but it has never been generally adopted. Seeing that the muscular tissue of the arterial wall has been destroyed, it can only act by inducing inflammatory thickening and sclerosis in the tissues around.

5. **Amputation** may be called for in the treatment of aneurisms under a variety of circumstances: (*a*) where gangrene of the limb has occurred or is imminent; (*b*) for diffusion or suppuration of an aneurism where everything else has failed; (*c*) for secondary hæmorrhage as a last resource; (*d*) in some cases of recurrent aneurism; (*e*) where joints have been opened or bones eroded to such an extent as to impair the utility of the limb; and finally, (*f*) in cases of subclavian aneurism amputation at the shoulder-joint has been practised in order to diminish the amount of blood flowing through the sac, and thus allow of a deposit of fibrin sufficient to cause consolidation of the tumour.

The Treatment of a Diffuse Aneurism differs somewhat according to whether the diffusion is slow or rapid. In the *leaking* aneurism, which increases in size somewhat slowly, the main vessel leading to the swelling may be tied, if this has not already been undertaken, and the influence of this measure, combined with rest, elevation, and careful general treatment, observed. Should the process of diffusion not be stayed, the case is treated as a diffuse or *ruptured* aneurism by laying open the sac after exsanguinating the limb by elevation and the use of an elastic band, and securing, if possible, the main vessel above and below, as also any branches which may open into the sac, if they can be found. If there is any evidence of incipient gangrene, or if secondary hæmorrhage supervenes, amputation must be undertaken. In such cases everything will depend on the efficient maintenance of asepsis.

The Treatment of an Inflamed Aneurism is always a matter of anxiety to the surgeon from the risk of recurrent and fatal hæmorrhage. *If the artery* above the aneurism *has not been previously ligatured*, it would certainly be correct practice to tie it, and watch the effect produced by that measure, together with rest, elevation, and the local application of an icebag. If the inflammatory symptoms still continue, the aneurism should be laid freely open after applying an elastic tourniquet, the coagula turned out, and the main trunk secured above and below. If bleeding still continues from smaller branches opening into the sac, the cavity is carefully plugged with antiseptic dressing, but a strict watch kept over the case, for fear of a return of the bleeding. Should this happen, or should gangrene threaten, amputation alone remains. *If the main vessel of supply has been previously tied*, the sac should still be laid open and cleared of coagula, all bleeding points secured if possible, and the cavity stuffed; but later on, unfortunately, amputation is very likely to be required.

Special Aneurisms.

Aneurism of the Thoracic Aorta is dealt with rather in medical than in surgical text-books; it is, however, of such importance as to demand a short notice here. Any part of the thoracic aorta may be affected, and the symptoms arising therefrom are very variable. The fusiform variety is most commonly met with in the early stages, a limited sacculation often supervening as the disease advances. In the *ascending part of the arch* the swelling rarely reaches any great size, especially if it is intra-pericardial, rupture of the sac even occurring before any marked pressure signs are evident. When arising from the *transverse part of the arch*, the symptoms vary somewhat with the direction taken by the enlargement. If it projects directly *upwards*, it may manifest itself as a pulsating tumour at the episternal notch, and then usually causes considerable cerebral effects by interference with the circulation through the carotids, or by pressure on the venous trunks. If it mainly extends *anteriorly*, it may form a large tumour without producing severe pressure effects, except the pain arising from its erosion of the thoracic wall; it sometimes appears as a pulsating swelling to the right of the sternum. If the enlargement takes place either *posteriorly* or *downwards* within the concavity of the arch, symptoms due to its presence, in the shape of dyspnœa and dysphagia, are early manifested from the close contiguity of the œsophagus, trachea, and pulmonary vessels. The former effect may also be due to pressure upon the left recurrent laryngeal nerve, causing paresis of the crico-arytenoideus posticus muscle, and difficulty in opening the glottis; the voice, moreover, becomes harsh and the cough hard, with what has been described as a 'metallic ring' about it, which is extremely characteristic. Laryngeal or tracheal stridor may be noticed in these cases, and a dragging of the trachea synchronous with the heart's action (the so-called 'tracheal tug').

Aneurisms of the *descending arch and thoracic aorta* often attain a considerable size, and may project posteriorly to the left of the vertebral column, causing a pulsating swelling. The only pressure symptoms which are very prominent are the pain due to erosion of ribs or vertebræ and the interference with deglutition from pressure on the œsophagus, which may be so great as to suggest the presence of an œsophageal constriction; and, in fact, before a bougie is passed in any case of œsophageal obstruction, it is always necessary to eliminate, if possible, the presence of an aneurism. Auscultation in the left vertebral groove may reveal the existence of a systolic bruit where such a condition exists.

Treatment.—As a rule, but little can be done beyond ordinary medical measures, such as rest, diet, and the administration of iodide of potassium. In some cases where the tumour could be felt in front, pressure over the sac, the application of an ice-bag, or the hypodermic injection of ergotin, have been employed, but without much effect; probably any improvement observed was due to the rest at the same time enforced. The introduction of coils of iron wire or horsehair has been attempted, and in one or two cases with partial or temporary success; whilst *electrolysis* has been employed where the patients were healthy and sacculated aneurisms, with but small openings into the aorta, supposed to exist. With the latter plan of treatment but little harm can be done, even if no good follow, and Bowditch has recorded thirty-seven cases so treated with seven cures, Tillmanns having also had two very successful cases. Macewen's method of acupuncture has been attended with some amount of benefit. Dyspnœa may be at times severe, but *tracheotomy* is rarely called for, and, indeed, had better be avoided if possible, death seldom resulting from this cause.

Surgical treatment, such as *ligature of the right carotid and right subclavian*, or of the left carotid alone, has been adopted in cases of aneurism of the ascending aorta or of the arch. A certain amount of improvement has followed some of the operations, but of eleven cases reported by Küster five died within the first ten days. The principles underlying such proceedings are certainly at variance with those guiding our usual treatment of an aneurism, and it is quite possible that the improvement is as much due to the accompanying rest in bed as to the operation.

Innominate Aneurism is usually of the tubular variety, and is frequently associated with a similar enlargement of the aorta. It presents a pulsating tumour behind the right sterno-clavicular articulation—*i.e.*, between the heads of origin of the sterno-mastoid—projecting either into the episternal notch or outwards into the subclavian triangle of the neck, and perhaps pushing the clavicle forwards. The effects produced by its pressure are very variable. The *pulse* in both the right temporal and radial arteries is diminished; *œdema* of a brawny character of the right side of the head and neck, and of the right arm, is caused by pressure on the right innominate vein, whilst less commonly similar changes on the left side may follow compression of the left vein; *pain* shooting into the neck and arm is often a marked symptom, arising from implication of the cervical and brachial nerves, whilst hyperæmia of the right side of the face and dilatation of the right pupil may result from irritation of the sympathetic trunk. *Dyspnœa* may be induced by direct pressure on the trachea, which may become displaced or flattened, or from irritation of the right recurrent laryngeal nerve, causing partial or complete paralysis of the right vocal cord. *Dysphagia* also sometimes occurs from pressure on the œsophagus.

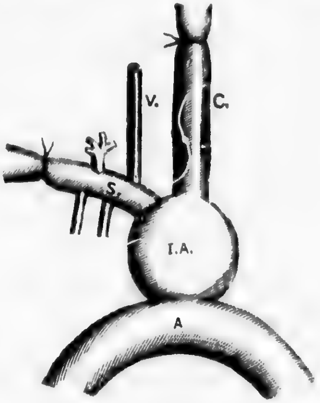


FIG. 77.—APPLICATION OF LIGATURES FOR INNOMINATE ANEURISM. (AFTER ERICHSEN.)

A, Aorta; IA, innominate aneurism; S, subclavian artery; C, carotid; V, vertebral artery.

The course of the case is progressive, but not necessarily rapid; death most commonly results from asphyxia or from rupture of the sac.

Treatment is mainly and most commonly medical. Rest and the administration of large doses of iodide of potassium may cause improvement, as also occasionally distal pressure. Of the operative measures to be adopted, distal ligature is the only feasible proceeding. Under any circumstances, it is impossible to cut off all the blood passing through the sac to the three main divisions—viz., the carotid, subclavian, and vertebral—with safety to the patient. Ligature of any one of these alone offers but little prospect of improvement; thus, the only case benefited by ligature of the subclavian was one treated by Wardrop, in which the carotid also had been independently and by accident blocked; whilst the only cure recorded after tying the carotid was probably due to subsequent suppuration within the sac (Evans). Ligature of both carotid and subclavian, with an interval of more than a week between the two operations, has practically the same effect as a single ligature, for by that time the collateral circulation will have been established. The results following such practice are better than those gained by ligating a single vessel, but not so good as those from tying both vessels at the same time (Fig. 77). Simultaneous ligature is doubtless the best plan of treatment to adopt; it places the sac in the best possible condition for the deposit of fibrin, whilst the additional step of tying the third part of the subclavian does not materially add to the risk of the operation, which is mainly due to the effect on the cerebral circulation.

Aneurism of the Common Carotid (the so-called carotid aneurism) is most usually situated in the upper part of the trunk near the bifurcation, and more often on the right than on the left side. The root of the right carotid as it springs from the innominate is also not unfrequently dilated, but the intra-thoracic portion of the left carotid is rarely affected. No other external vessel is so frequently the seat of aneurism in women.

The usual intrinsic *signs* of an aneurism are present, and the pressure symptoms are mainly referable to interference with the cerebral circulation, to irritation of the cervical sympathetic trunk, or to pressure upon the larynx, pharynx, or trachea. As a rule, the progress of these cases is slow.

Diagnosis.—*From similar disease at the root of the neck* the distinction is often made with difficulty, as either an aortic, innominate or subclavian aneurism may push upwards so as to simulate it somewhat closely. Percussion and auscultation of the upper part of the chest, as also a careful investigation into the history of the case, and a digital examination of the limits of the pulsating mass, may suffice to determine the point. Holmes suggests trying the effect of carefully applied distal pressure for a few hours; in a carotid aneurism the tension becomes distinctly less as soon as the collateral circulation commences to enlarge, whilst in an aortic aneurism no difference is observed. The pressure effects must also be carefully considered. 'Pressure on the left recurrent laryngeal nerve would distinguish an aortic aneurism from one on the right vessels; pressure on the right nerve in like manner excludes an aortic aneurism. Pressure on the left innominate vein indicates aortic aneurism rather than innominate; compression of the internal jugular or subclavian vein only points to carotid or subclavian aneurism. A "tracheal tug" indicates an aneurism of the aorta' (P. Gould). The differences in the peripheral pulses may also give useful information. The two radial pulses should be first examined; if they are equally affected, an aneurism of the aorta on the cardiac side of the innominate is indicated; if they are equal and normal, an aneurism on the distal side of the left subclavian. If the left radial pulse is alone aneurismal, the root of the left subclavian is diseased; whilst if the left temporal is also affected, it suggests an aneurism of the transverse part of the arch beyond the innominate. When both radial and temporal vessels on the right side show signs of interference with the pulse, innominate aneurism is probably present; whilst an affection of only one of these branches indicates that the corresponding carotid or subclavian is dilated. One source of fallacy must not be forgotten, viz., that any one of these trunks may be occluded or compressed by a neighbouring aneurism without being dilated, and hence the quality of the pulse must be taken into consideration rather than its actual volume, and to this end the sphygmograph is a useful adjunct in diagnosis. From *abscess, tumours, or enlarged glands* with a transmitted impulse, it is recognised by an application of the general principles detailed above (p. 251); but when the artery communicates an impulse to a mass through which it passes, only very careful examination will reveal the exact nature of the case. *Pulsating or cystic goitre* may be distinguished from a carotid aneurism by noting that the goitre is not, as a rule, limited to one side of the neck, the isthmus being also involved; that the most fixed part of the tumour is in the median line, and not under the sterno-mastoid muscle, and that the swelling moves up and down during deglutition, an aneurism remaining fixed.

Treatment.—Where the aneurism has been situated near the bifurcation, *compression* has been practised with advantage in a few cases, the vessel being controlled above the transverse process of the sixth vertebra, so as not to interfere with the circulation through the vertebral. *Ligature* of the carotid above or below the omo-hyoid is, however, the treatment usually adopted, and generally with great success. If the aneurism is near the root of the neck, proximal ligature becomes impracticable, and the distal operation (Brasdor's) must be resorted to; the results of the cases already treated in this way are such as to justify surgeons in continuing the practice.

Aneurism of the External Carotid is seldom met with, except as an extension of one involving the bifurcation. The usual phenomena are presented near the angle of the jaw, and well above the cricoid cartilage. Pressure results are early experienced, *e.g.*, paralysis of one side of the tongue, aphonia, or dysphagia. Ligature of the common trunk above the omo-hyoid is the proper line of treatment, or, failing that, the sac may be dissected out after securing the branches arising from it.

Aneurism of the Internal Carotid (extracranial portion).—There is but little difference between the symptoms arising from this condition and those caused by an aneurism of the bifurcation or of the external carotid, except that the swelling tends to project more into the pharynx, from which it is separated merely by the pharyngeal wall. It appears as a tense projecting pulsating tumour, placed immediately under the mucous membrane, and looking dangerously like an abscess of the tonsil. The **Treatment** consists in tying the common carotid.

Intracranial Aneurism.—Any of the arteries within the skull may become the site of an aneurism, but this condition occurs more commonly upon the internal carotid and its branches than upon those arising from the vertebrals, although the basilar artery is more often affected than any other single vessel. The aneurisms are generally fusiform in character, and their origin is often extremely obscure, a blow or fall being sometimes adduced to explain them; in children they are stated to result from the lodgment of irritating emboli. They sometimes grow to a considerable size before causing obvious symptoms; the patient may, in fact, have continued without any manifestation of the disease, until suddenly seized with a rapidly fatal apoplexy due to its rupture. If there are any symptoms, they are due rather to compression of the brain than to erosion of the more resistant bony structures. Pain may be complained of which is more or less fixed and continuous, or there may be a feeling of pulsation, or of opening and shutting the top of the skull. Sight, hearing, and other functions of the brain, may also be interfered with, but physical changes in the eyes, such as optic neuritis or atrophy, are not met with, unless there is direct pressure on some part of the optic tract. Occasionally a loud whizzing bruit may be heard on auscultating the skull. The only **Treatment** possible, if a diagnosis can be established, is ligature of the common carotid artery, and even this will be of little use if the basilar is affected.

An **Intra-orbital Aneurism** is recognised by the existence of a pulsating swelling of the orbit, causing protrusion of the eyeball (exophthalmos) and congestion of the conjunctival and deeper vessels. A feeling of pain or tension in the orbit may exist, and gradually vision is impaired, whilst the cornea may become opaque from exposure, due to the inability of the lids to cover it; finally, the whole globe may be disorganized. The symptoms sometimes commence with a definite snap or crack, as though something had given way in the orbit; or they may be due to a penetrating injury or to a blow. Occasionally the condition is congenital, or arises soon after birth.

Several pathological conditions are included under the title 'intra-orbital aneurism': (*a*) if congenital, it is probably a case of aneurism by anastomosis; this, however, is not common, being only present in two out of seventy-three cases collected by Rivington; (*b*) if traumatic in origin, whether due to a penetrating injury or not, the case is probably one of aneurismal varix between the internal carotid and cavernous sinus, or of true traumatic aneurism of the ophthalmic artery; (*c*) if idiopathic, it is probably due to thrombosis of the cavernous sinus, or to spontaneous aneurism of the internal carotid or ophthalmic arteries, producing pressure upon the venous return.

Diagnosis.—To determine the precise cause of a pulsating tumour of the orbit is by no means an easy matter, inasmuch as sarcomata of the orbital walls are occasionally met with exhibiting many of the characters of intra-orbital aneurism. Careful manipulation will, however, generally demonstrate the existence of a more definite tumour, and a less-marked expansile pulsation in the sarcoma, whilst the bruit is less distinct. The distortion of the eyeball and ocular axis is often considerable in these malignant tumours, but vision is not so early affected.

Treatment.—Electrolysis and ligature of the common carotid are the only means which hold out any prospect of success, and of these the former should always be first tried. In the congenital cases its application has been very successful, but in those due to trauma it is very likely to fail, and then operation is required.

Subclavian Aneurism is most frequently met with amongst men, and particularly those who have to use their arms much in lifting, such as soldiers and sailors; the right vessel is more often affected than the left. Any part of the artery may be involved, but the greatest dilatation naturally occurs in the third portion, giving rise to a pulsating tumour in the subclavian triangle of the neck. It may reach above the clavicle, but extends mainly backwards, outwards, and downwards, causing severe pressure effects upon the vessels and nerves of the arm, and may also occasion hiccough by pressure on the phrenic nerve. Occasionally it encroaches on the dome of the pleura and apex of the lung, and has been known to burst into the lung or pleural cavity. It does not increase in size very rapidly, being surrounded by dense unyielding structures, and it never compresses the trachea or œsophagus.

No difficulty presents itself in **Diagnosis**, as a rule, although in the early stages it may be somewhat simulated by a normal artery pushed forwards by an exostosis of the first rib, or by a supernumerary cervical rib. A pulsating sarcoma growing from any of the neighbouring structures may also resemble it somewhat closely, but the pulsation is then rarely so limited in extent as in an aneurism, and a definite tumour can usually be felt.

The **Treatment** of subclavian aneurism is surrounded with difficulties, and the results hitherto obtained have been most unsatisfactory. It is seldom that any undilated portion of the artery is left outside the thorax, otherwise *digital compression on the cardiac side* might be attempted, since it has been employed with success in a few instances. Direct pressure, manipulation, galvanopuncture or needling the sac according to Macewen's method, have been adopted with occasional successes, but cannot be depended upon. *Ligature of the innominate trunk* suggests itself as the operation to be adopted for cure by the Hunterian method, and the recent records of the operation would certainly encourage one to repeat it in any suitable case, since most of the fatal results occurred prior to the introduction of antiseptic surgery, death resulting from sepsis or secondary hæmorrhage. It would appear that the simultaneous ligature of the carotid or vertebral trunks with the innominate is essential to success, in order to prevent the rapid backflow on the distal side of the ligature which otherwise occurs. This course was followed by Coppinger (January, 1893) with complete success, as also by Lewtas (1889), Banks (1883), Burrell, C. J. Symonds (1894), and Smyth of New Orleans (1865), the only surgeons whose patients have lived. In the last case secondary hæmorrhage ensued, which was, however, controlled by tying the vertebral and filling the wound with shot, the patient subsequently living for ten years.

Ligature of the first part of the subclavian has also been attempted for the cure of aneurisms involving the lower part of the vessel, but it must be considered an utterly unjustifiable proceeding; for of the nineteen cases operated on, all have died. *Distal ligature of the third part* of the subclavian has also been attempted, but without much success.

What treatment, then, is to be adopted as a last resource, where the above measures are impracticable or have failed? The plan suggested by the late Sir William Fergusson must then be followed, viz., *amputation at the shoulder-joint and distal ligature* as near the sac as possible. Distal ligature alone is usually unsuccessful, owing to the fact that the great bulk of the blood needed for the nutrition of the arm still passes through the sac, and there is no means of checking this except by the removal of the limb. A few successful cases of such heroic treatment have been reported.

Axillary Aneurism is usually the result of falls on the outstretched arm, or injuries to the shoulder, such as fractures or dislocations, or of the surgeon's attempts to reduce them. The **Symptoms** are merely those due to the presence of a pulsating tumour and its pressure, which may cause pain, local and neuralgic, or œdema of the arm. When the upper part of the vessel is affected, a pulsating swelling is felt immediately below the clavicle, whilst if placed lower down it projects more into the axilla, and may totally fill up the hollow. Occasionally the clavicle is displaced upwards, or the aneurism may extend beneath it into the neck, conditions of serious import as regards treatment. The **Diagnosis** should not be difficult. *Chronic enlargement and abscess of the axillary glands* with a transmitted impulse are readily distinguished by careful manipulation, and attention to the rules already given ; a *pulsating sarcoma of the head of the humerus* is recognised from it by a careful consideration of the method of onset, and of the original situation of the swelling, as well as by a careful digital examination.

Treatment.—Compression or ligature of the third part of the subclavian artery will be required, and both plans have been successfully adopted. The former must be carried out by means of digital pressure, and will probably have to extend over a considerable period of time. Where ligature is employed, great care must be taken not to wound the branches which carry on the collateral circulation. If the aneurismal sac extends under the clavicle, it may be necessary to secure the second part of the artery, due attention being directed to maintaining the integrity of the phrenic nerve.

Aneurisms of the brachial artery, or of any of the vessels of the forearm, require no special notice here. They are almost invariably traumatic in origin, and should be treated by extirpation.

Abdominal Aneurism.—The abdominal aorta may become the seat of aneurism, either at the upper part near the origin of the cœliac axis, or at the bifurcation ; in the former case, some of the branches arising at that spot are also usually involved, and the disease is of the sacculated type. Occasionally aneurisms form independently on the splenic or mesenteric vessels.

Signs.—A pulsating tumour is observed, usually near the middle line, and either close to the umbilicus or in the epigastric notch ; the pulsation is expansile in type, and remains the same in character whatever the position of the patient, whilst various kinds of bruit have been noticed. Pressure signs are mainly confined to pain, localized in the back from erosion of the vertebræ, or neuralgic from pressure on the solar plexus or lumbar nerves, whilst œdema of the lower extremities may arise from compression of the vena cava. There may be some concurrent derangement of the intestinal functions.

Diagnosis.—There are many conditions which give rise to epigastric pulsation, but the majority of them can be readily distinguished from abdominal aneurism by careful examination, if necessary, under an anæsthetic. Cardiac pulsations may be felt in the epigastrium when the heart is dilated, but should be easily recognised; as also a derived impulse from the aorta in a collection of fæces, or a cancerous growth. The examination of such a patient should be conducted not only in the dorsal decubitus, but also with the patient lying on his abdomen, or kneeling forwards so as to remove the weight of the viscera from the aorta. The pulsation will under such circumstances cease, or become much diminished, and thus a negative diagnosis may be established. A large accumulation of abdominal fat will seriously interfere with any satisfactory investigation.

The **Treatment** of abdominal aneurism is necessarily one of great difficulty from its position and relations. Ligature of the vessel even on the distal side has never yet been attempted, and hence, failing medical treatment by rest and diet, *compression* has usually been relied on, which has been applied both on the distal and proximal sides of the sac. In six cases of proximal compression three successes were reported, one failure, and two deaths; in four cases of distal pressure, two failures and two deaths. Chloroform is needed for the application, and Lister's tourniquet has usually been employed. The patient's diet is limited on the preceding day, and only fluid nutriment given on the day itself; the bowels must be thoroughly and completely emptied. Care must be taken not to injuriously compress the viscera, for the pressure has often to be maintained for some considerable time, varying from one to twenty hours; if properly applied, but little force is needed. It is still within the realm of possibility that ligature of the aorta in a suitable case may prove successful. More recently treatment by needling the sac has been employed, and certainly in Macewen's hands at least one case has been brilliantly successful. There is also one instance on record where the introduction of iron wire into the sac caused temporary improvement.

Iliac or Inguinal Aneurism may arise from either the common or external iliac, or from the common femoral, and usually tends to spread upwards towards the abdominal cavity. It is frequently sacculated in type, and tends sooner or later to become diffuse. Its shape is sometimes determined by the unequal pressure exercised by fascial or other structures, leading to lobulation. The symptoms are very typical, and pressure effects are mainly experienced in the veins and nerves of the leg. The **Diagnosis** cannot be well mistaken in the early stages, but later on, and especially when situated somewhat higher than usual, it may be difficult to distinguish from a pulsating sarcoma. In such cases the difficulty has been so great as even to mislead men like Syme and Stanley.

Treatment.—Medical treatment alone is of little avail in curing inguinal aneurisms; but proximal compression of the aorta or common iliac, where the situation of the swelling and the thickness of the abdominal parietes permitted it, has had a certain amount of success. It is carried out by means of a tourniquet, shot-bag, or the fingers, and may be advantageously combined with distal pressure. *Ligature of the external iliac* has been frequently performed for inguinal aneurism, and with such success as to warrant its being employed in all suitable cases. *Ligature of the common iliac* is sometimes needed for aneurisms in the iliac fossa. The results of the retro-peritoneal operation were by no means satisfactory, Kümmell (1884) reporting thirty-two cases in which it had been tied for aneurism, with twenty-two deaths; probably the introduction of the trans-peritoneal method of ligature will lead to better results. In seven instances *ligature of the abdominal aorta* has been undertaken for iliac or inguinal aneurism, and in all a fatal issue has followed, six of the patients dying within forty-eight hours, only one surviving as long as the tenth day.

Aneurisms of the Gluteal and Sciatic Arteries are not uncommonly traumatic in origin, and present as pulsating swellings of variable size in the buttock, the gluteal situated at the upper part of the sciatic notch, whilst the sciatic lies more deeply, and may be partly intrapelvic. Pulsation is well marked, and murmurs are heard on auscultation. Pain in the limb from pressure on the sciatic nerve is a prominent symptom, especially in the sciatic variety. The **Diagnosis** is by no means simple, especially from a pulsating sarcoma, and many instances of mistakes have occurred even in the practice of eminent surgeons. Many plans of **Treatment** have been adopted, but possibly the best results hitherto obtained have followed the laying open of the sac, turning out the clot, and tying the affected trunk. Ligature of the internal iliac has also been performed, and with a creditable degree of success, even where the old extra-peritoneal method was employed. The use of the trans-peritoneal plan greatly simplifies the operation, and the more recent records of this proceeding are most satisfactory. At the present time it should certainly be undertaken in preference to the plan of laying open the sac.

Femoral Aneurism is the title given to one forming in the course of the superficial femoral artery. It is not uncommonly tubular, and occurs almost invariably in males, and as often on one side of the body as the other. The **Diagnosis** needs no discussion, as the disease runs a typical course, and the **Treatment** consists either in compression at the groin, or ligature of the common or superficial femoral trunk.

Aneurism of the Profunda Femoris Artery is a very rare condition, presenting the ordinary features of a pulsating tumour situated amongst the muscles on the inner side of the thigh, but causing no diminution of the pulse in the popliteal or tibial vessels. The superficial femoral may be felt coursing over it, but quite distinct from it. Compression by a shot-bag in the groin, or by a tourniquet, may be sufficient to effect a cure, whilst ligature of the common femoral or external iliac may be resorted to, if necessary.

Popliteal Aneurism (Fig. 78) occurs almost invariably in men, and particularly in sailors (Cripps). It constitutes a pulsating tumour in the ham, rendering the knee painful and stiff, and so much do the symptoms resemble those of chronic rheumatism, that in every such case the popliteal space should be examined. The limb is usually semiflexed, and the aneurism, which is of a sacculated type, tends to increase rapidly. If the main swelling is situated to the front of the vessel, there is danger later on of the knee-joint becoming implicated, and neighbouring bones carious; when it extends posteriorly, diffusion is a not uncommon complication, and is very likely to lead to gangrene, on account of the pressure exercised not only upon the vein, but also upon the articular branches of the popliteal artery, which are most important factors in maintaining the collateral circulation. The **diagnosis** has to be made from chronic enlargement and abscess of the glands in the ham, but in these there is no disturbance of the circulation in the foot; from bursal tumours, by their want of mobility and pulsation; or from solid tumours, *e.g.*, pulsating sarcoma of the femur or tibia, from which it can be recognised by attention to the general principles already described. In a few instances spontaneous cure has resulted from the pressure of the sac upon the artery above.

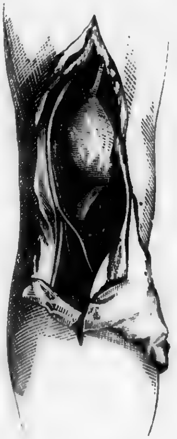


FIG. 78.—POPLITEAL ANEURISM.

Treatment.—Compression is eminently successful in many of these cases, whether applied in the groin or by Esmarch's method. Ligature of the femoral artery at the apex of Scarpa's triangle is, however, the plan most commonly adopted, and with the greatest success. In cases where either of these methods have failed, or where the aneurism has become diffuse or recurred, extirpation of the sac is the best course to adopt.

Ligature of Vessels.

As already mentioned, arteries may need to be ligatured under two conditions, either when divided on the face of a wound, or in their continuity. We purpose to deal only with the latter in this section.

Ligation in continuity is an operation performed to arrest the flow of blood to the periphery, in order either to check hæmorrhage, as from a wound, or to promote the cure of an aneurism, or to diminish the rate of growth of some tumour, or to beneficially influence some peripheral organ by reducing its blood-supply (as in tying the internal iliac for enlarged prostate), or as a preliminary to removing some vascular structure, such as the tongue.

The **Instruments** needed are as follows: scalpels, dissecting forceps, director or blunt dissector, forcipressure or artery forceps, blunt hooks, retractors for deep wounds, aneurism needle, ligature, needles, and sutures.

The **Material** to be employed for the ligature has been discussed elsewhere. Sulphuro-chromicised catgut is that most commonly employed, and for its application to an artery in its continuity the following plan may be adopted: A fine loop of catgut having been passed under the vessel by means of an aneurism needle, a prepared ligature, consisting of three strands of catgut about 10 inches long, knotted together at each end, is threaded through the loop, which is then withdrawn, carrying the ligature under the vessel. The advantages of this method are, that the aneurism needle being threaded with such fine gut, passes easily and without friction, whilst the use of the loop to draw the ligature back obviates the difficulty, where the artery is deeply placed, of threading the needle when passed unarmed, as is sometimes advised. The substitution of three strands for a single ligature distributes the pressure over a larger area, and is considered more certainly to effect occlusion.

As to the **Operation** itself, the strictest asepsis must be maintained, the skin and instruments being thoroughly purified previously. The artery must be subcutaneously examined as far as is possible, so that a suitable portion may be selected for applying the ligature. An incision is made cleanly and neatly through the skin and subcutaneous tissues, and of sufficient size to allow of the necessary manipulations. The various structures met with on the way to the artery are recognised, and drawn, if need be, to one or the other side, so as to lay bare the sheath of the vessel. It is most important that these anatomical landmarks or *rallying points* should each be seen or felt in order, so that the operator may not be led astray or miss the vessel. Naturally it is easier to find the artery in the living subject than in the dead, the pulsation being of the greatest assistance. The sheath, having been exposed, must now be opened over the situation of the artery by a few delicate strokes of the knife; a portion of the sheath should be picked up between the blades of the forceps, incised along the longitudinal axis, and stripped off the artery, taking care to keep the back of the knife towards the vessel. This incision should be about ¾ inch in length, and should open not only the general, but also the special, sheath of the artery, if such exist. Each side of the incision in the sheath may then be grasped with catch forceps, so as to steady it, whilst the aneurism needle is inserted unarmed, and gently manipulated up and down, so as to free the vessel all round, a matter of no great difficulty, if the sheath has been fairly opened, and the white glistening arterial wall sufficiently exposed. The ligature may then be passed through the eye of the needle and carried round the vessel. It is tied in a direction exactly at right angles to the longitudinal axis, and in doing so the artery must not be dragged out of its sheath, but the ligature should be tightened by the tips of the forefingers meeting upon it (Fig. 79). The reef-knot is all that is needed for security; more complicated knots are too bulky to be recommended.

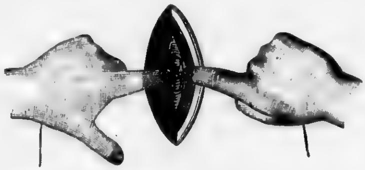


FIG. 79.—POSITION OF FINGERS AND HANDS IN TYING LIGATURE. (TILLMANNS.)

The rule usually followed is to pass the needle *from important structures, such as the vein*, but really this is a matter of little importance when the above directions have been carefully carried out, and especially in superficial vessels. *Should the vein be accidentally punctured*, the needle must be at once withdrawn, and the puncture in the vein carefully secured by ligature, whilst the artery is tied a little higher or lower. In dealing, however, with the smaller vessels, where the venæ comites are in close contact with the artery, no harm will attend their inclusion in the ligature.

We have already discussed the desirability of so tightening the ligature as to divide the inner and middle coats; it is possible, however, that in very large trunks like the innominate it is wiser only to completely approximate the walls by some thick animal substance, such as kangaroo tendon, and not to attempt any rupture of the intima.

It is a well known fact that all arteries are maintained in the body more or less upon the stretch, as evidenced by their retraction within the sheath on complete division. There must therefore always be a certain amount of longitudinal tension upon any part of an artery to which a ligature has been applied in its continuity, a condition which may presumably predispose to secondary hæmorrhage. To obviate this, it has been suggested that a double ligature should be applied, and the vessel divided between them. This plan may be used with advantage in situations where the artery can be readily reached, but is scarcely feasible in some of the deeper operations; it is probable that the results thereby obtained are better than when a single ligature is employed.

After-Treatment.—The ordinary antiseptic precautions are taken in regard to the wound, which should be healed and all stitches removed in eight days; but the patient must be kept at rest for some time longer to allow the tissues to consolidate, especially in dealing with the larger vessels and in elderly people. When the main trunk to one of the extremities has been tied, the limb should be wrapped in cotton-wool and slightly raised, so as to assist venous return without interfering with the arterial supply. If there is any likelihood of gangrene, as in the lower limbs of elderly people, the extremity should be thoroughly purified, and wrapped in aseptic wool immediately after the operation, in order to avoid septic complications.

There are two great **dangers** liable to follow the ligation of an artery in its continuity:

1. **Secondary Hæmorrhage** (*vide* p. 227).

2. **Gangrene**, which may arise from a variety of causes: (*a*) From simple loss of vitality, the maximum amount of blood transmitted by the collateral circulation being insufficient to maintain in life the whole of the part supplied by the vessel ligated. This is particularly the case when the peripheral vessels are in a condition of calcareous degeneration. The tissues which receive the smallest amount of blood die first, *e.g.*, the fingers or toes, or the subcortical white substance of the brain. A severe loss of blood after the operation, as from secondary hæmorrhage, is also sufficient in some cases to determine tissue necrosis. Under such circumstances it always takes on the dry form if involving the terminal joints of a limb, but in more fleshy parts it may be moist. (*b*) Interference with the venous return, as by injury to the vein during operation, such as inclusion in the ligature, or thrombosis induced subsequently by septic periphlebitis, is very likely to cause gangrene, and then it is of the moist type; the injurious pressure of a tight bandage, obstructing the venous circulation, will have a similar effect. (*c*) Injudicious after-treatment, such as too great elevation of the limb, the application of cold lotions, an icebag, or hot fomentations during the period of diminished vitality immediately following the operation, or even an attack of erysipelas may also bring about the death of some of the tissues involved.

Every precaution must be taken to prevent the occurrence of gangrene, as indicated above, and as soon as there is any suspicion of its onset the whole limb must be thoroughly purified, and maintained subsequently aseptic. As a general rule, the **Treatment** of aseptic gangrene following ligature is expectant in character, the parts being allowed to separate naturally. But if there is much pain, or any tendency to spread, or if septic mischief is present, giving rise to fever and general disturbance, it is wiser either to amputate on a level with the original wound, or, if this is near the trunk, as in ligature of the femoral at the apex of Scarpa's triangle, to remove the limb well above the line of demarcation.

The **Innominate Artery**, as already mentioned (p. 267), has now been tied with success on six separate occasions out of a total of twenty-five operations, and it may be anticipated that a rigid asepsis will enable surgeons to deal with this vessel in the future without the terrible mortality that has hitherto accompanied the operation, especially if the carotid and vertebral are also secured at the same time.

Operation.—An incision is made along the lower third of the anterior border of the sterno-mastoid, and is prolonged downwards to sweep over the upper edge of the episternal notch. The platysma, the superficial and deep fasciæ are divided, and the anterior jugular vein secured if necessary between two ligatures; the sterno-mastoid is drawn outwards, and, if need be, its inner tendinous fibres are divided, whilst the sterno-hyoid and -thyroid muscles are severed close to the sternum and drawn inwards. The sheath of the common carotid artery is now laid bare and opened at its lower part, so as to expose the vessel and enable it to be tied, and by following this downwards the innominate trunk is reached. In some cases it may expedite matters to remove portions of the sternum and inner end of the clavicle. The right internal jugular and innominate veins lie to the outer side of the vessel, but if much engorged may project over the artery, and must then be drawn aside by retractors, whilst the inferior thyroid plexus may course directly in front of the vessel, and even need to be ligatured. To the outer or right side are placed the vagus nerve and pleural sac, and these must be carefully separated from the artery whilst the needle is passed from without inwards, and from below upwards. A double-curved aneurism needle will probably be required to effect this. A broad animal ligature—*e.g.*, a strip of ox-aorta or kangaroo-tendon—should be used for this vessel. Asepsis must be most thoroughly attended to, and every means adopted to ensure healing by first intention.

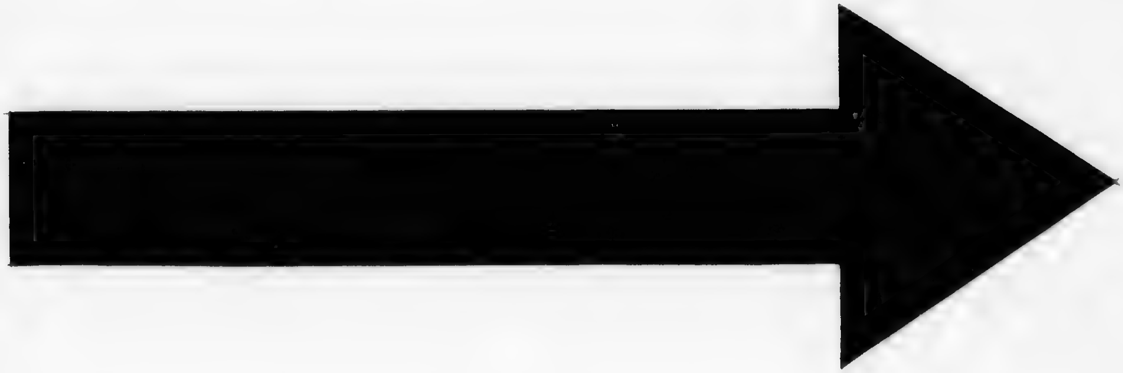
Collateral Circulation.—*Intracranial:* Vertebrals and carotids in circle of Willis.

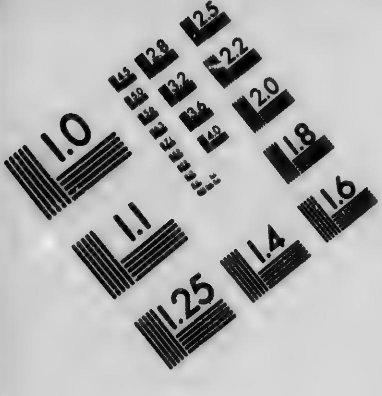
Face and Neck: Branches of the two external carotids across middle line.

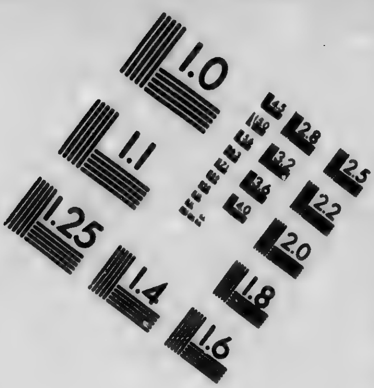
Trunk: First aortic intercostal *with* superior intercostal of subclavian; upper aortic intercostals *with* thoracic branches of axillary and intercostals of internal mammary; deep epigastric and phrenic *with* terminal divisions of internal mammary.

The **Carotid Artery** may be tied at one of two places, either above or below the spot at which it is crossed by the anterior belly of the omo-hyoid, a point corresponding to the transverse process of the sixth cervical vertebra (Chassaignac's tubercle). The line of the vessel is indicated by that drawn from the sterno-clavicular articulation to a point midway between the angle of the jaw and the tip of the mastoid process, the bifurcation being situated on a level with the upper border of the thyroid cartilage.

Ligature above the Omo-hyoid.—This operation is always to be chosen if practicable, the ligature being applied at a spot corresponding in level to the cricoid cartilage. The patient lies upon the back, with the chin raised and the







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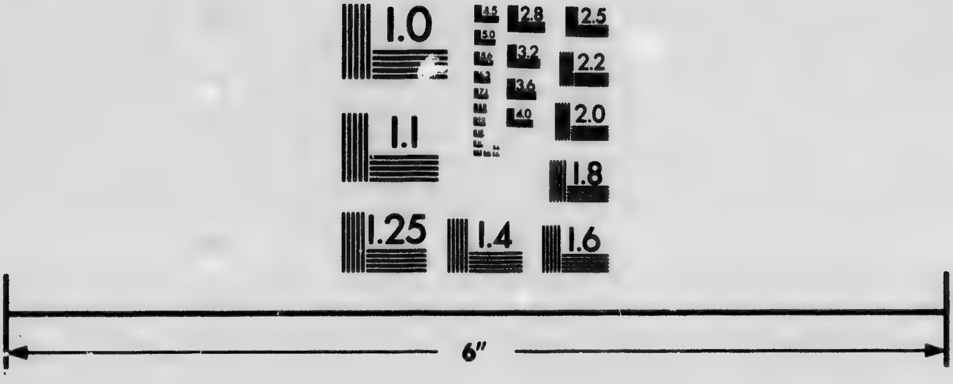

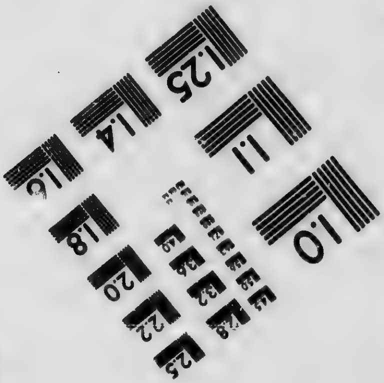

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head turned a little towards the opposite side. A 3-inch incision is made in the line of the vessel, the centre on a level with the cricoid (Fig. 80, A). The skin, platysma, and fasciæ are divided, and the anterior edge of the sterno-mastoid defined as the first rallying-point. The deep fascia is incised along its inner border, so that it may be drawn aside by a retractor; the sterno-mastoid branch of the superior thyroid artery may be divided at this stage, and a vein passing between the facial and anterior jugular may also need to be ligatured. On the inner side of the wound the omo-hyoid muscle must now be looked for, trending forwards and upwards from under cover of the sterno-mastoid. In the angle formed by these two structures the pulsation of the vessel should be felt and the sheath readily recognised, with the descendens cervicis nerve upon it. It is opened on the inner side, and the artery well cleared. The needle is passed from without inwards, and if the sheath has been efficiently opened, the vagus nerve will run no risk of being included in the ligature.

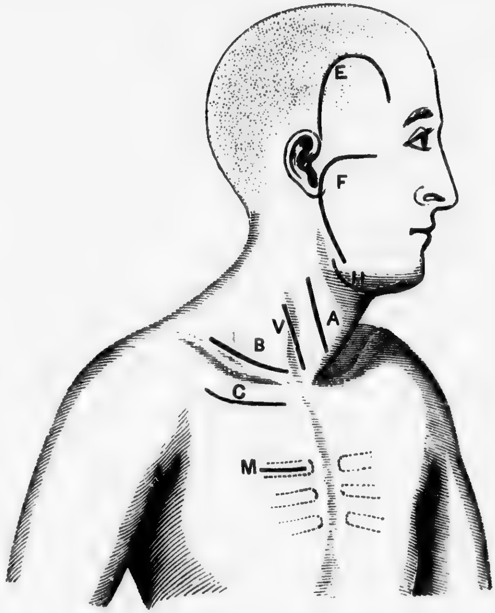

FIG. 80.—INCISIONS FOR VARIOUS OPERATIONS ON HEAD AND NECK.

A, For ligature of carotid; V, for ligature of vertebral artery; B, for ligature of subclavian; C, for ligature of the first part of the axillary; M, for the internal mammary; H, for the lingual; E, flap incision used in trephining for meningeal hæmorrhage; F, flap incision for operations on the roots of the fifth nerve.

Ligature below the Omo-hyoid.—The incision is made in a similar direction to the above, but lower in the neck, reaching from the cricoid cartilage nearly to the sterno-clavicular joint. The sterno-mastoid is drawn outwards, and perhaps the anterior fibres may need to be divided; the sterno-hyoid and -thyroid muscles are retracted inwards or divided, and the omo-hyoid can usually be drawn upwards. The sheath is thus exposed, and opened on the inner side, the needle being passed as in the previous operation. It must be remembered that both internal jugular veins are directed towards the right side in the lower part of their course, and hence the left vein is likely to lie somewhat in front of the artery. The inferior thyroid veins may also be met with, and need to be drawn aside or ligatured.

The *effects* of ligature of the carotid upon the brain are of great interest and importance. Statistics go to prove that in about 25 per cent. of the patients operated on cerebral symptoms manifest themselves, either immediately in the form of syncope from cerebral anæmia, or in the course of a few days from cerebral softening, causing convulsions, coma, and even death. A fatal issue is likely to result in about half the cases thus affected. Occasionally a somewhat acute form of congestion of the lungs follows ligature of the carotid within a few hours, possibly due to interference with the circulation in the medulla, or to irritation or injury to the vagus or sympathetics; it may run on to subacute inflammation, and is best remedied by free stimulation, or even venesection.

Collateral Circulation.—*Intracranial:* Circle of Willis.

Extracranial: Communications across the middle line of branches of the external carotids and vertebrals; inferior thyroid *with* the superior thyroid; profunda cervicis *with* princeps cervicis of occipital; superficial cervical *with* branches of occipital and vertebral.

Ligature of the Internal Carotid is but rarely needed, but has been employed for hæmorrhage and traumatic aneurisms. Any part of the vessel may be tied, but, as a rule, the ligature is placed just above the bifurcation. The operation is practically the same as for securing the common carotid, but at a higher spot. An incision is made along the anterior border of the sterno-mastoid, its centre being nearly opposite the great cornu of the hyoid bone; the muscle is pulled well backwards, and the posterior belly of the digastric is now seen and drawn up. The external carotid presents itself, and is carefully displaced inwards, and then the internal carotid in its sheath appears. This is opened, and the aneurism needle passed from the jugular vein—*i.e.*, from without inwards.

The **Collateral Circulation** to the brain is maintained by the circle of Willis.

Ligature of the External Carotid is occasionally called for, the site of election for applying the ligature being between the superior thyroid and lingual branches. An incision is made along the anterior border of the sterno-mastoid, 3 inches in length, its centre corresponding to the great cornu of the hyoid bone. The edge of the muscle is defined and drawn outwards, and the posterior belly of the digastric sought for above, the hypoglossal nerve lying just below it. The sheath is now opened below the tip of the great cornu of the hyoid, and the needle passed from without inwards. The operation may be rendered exceedingly difficult by the presence of enlarged glands or veins, especially the lingual, facial and superior thyroid, which often lie directly in front of the vessel. The superior laryngeal nerve is placed immediately behind it, and must necessarily be avoided.

Collateral Circulation. — *Vide* ligature of common carotid (extracranial portion).

Ligature of the Lingual Artery is chiefly needed in malignant disease of the tongue, either with a view to arrest the growth, or to control hæmorrhage, or as a preliminary to removal of the organ; it is also occasionally employed in traumatic cases. The vessel can be secured either close to its origin from the external carotid, or in the submaxillary triangle under cover of the hyo-glossus muscle. The latter operation is more commonly performed, but the former is the better proceeding, inasmuch as the dorsal branches arising from the vessel at the posterior border of the hyo-glossus are also included by this means.

In the Submaxillary Triangle (site of election).—The patient lies on the back, with the shoulders raised, and the head extended backwards and turned to the opposite side. A crescentic incision commencing about 1 inch below and external to the symphysis menti, and skirting the angle of the jaw, is made, the centre opposite the great cornu of the hyoid bone (Fig. 80, H). The integuments and platysma are divided, and the lower border of the submaxillary gland defined, and along it the deep fascia is incised. The gland is now drawn upwards, and held over the margin of the jaw with a retractor (Fig. 81, *Gs*). On thoroughly opening up the wound the two bellies of the digastric muscle (*M. biv*) are seen converging to the hyoid bone (*Z*), the anterior belly passing superficial to the fibres of the mylo-hyoid muscle (*M. myho*), which course nearly transversely to the mandible. The digastric tendon may be drawn down with a blunt hook, and in the space thus cleared the hyo-glossus muscle (*M. hyogl.*) becomes evident, with its fibres passing vertically upwards, and resting upon it the hypoglossal nerve (5), coursing forwards to get under cover of the mylo-hyoid, and a little lower the ranine vein. The fibres of the hyo-glossus are now divided transversely midway between the nerve and the hyoid bone, and in the opening made by their retraction is seen the artery (3), which can be readily secured. Should it not be found in this situation, the incision in the hyo-glossus should be extended backwards, and the vessel will then usually come in sight.

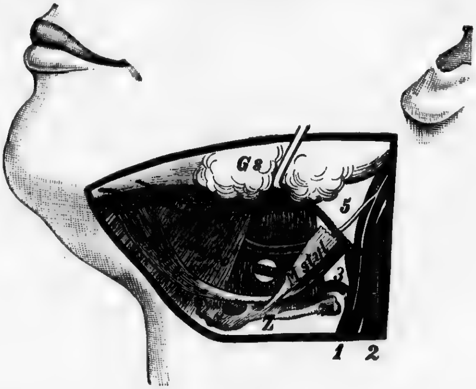

FIG. 81.—LIGATURE OF LINGUAL ARTERY. (TILLMANNS.)

The submaxillary gland (*Gs*) has been drawn over the side of the jaw with a hook; *Z*, hyoid bone; 1, external carotid; 2, internal jugular; 3, lingual artery; 4, ranine branch of facial; 5, hypoglossal nerve; *M biv*, digastric; *M styl*, stylo-hyoid; *M myho*, mylo-hyoid; *M hyogl*, hyoglossus. The place where the artery is tied is indicated by a window in the hyoglossus, through which it can be seen.

In the Neck close to its Origin.—An incision is made along the anterior border of the sterno-mastoid similar to that needed for ligature of the external carotid. The anterior border of the muscle is drawn outwards, and the great cornu of the hyoid bone defined. A small space is now distinguished between that bony process and the posterior belly of the digastric, in which the artery can be felt resting upon the middle constrictor, and secured just as it rises from the external carotid. The operation is by no means so simple as the former.

The **Facial Artery** may be exposed and tied through a horizontal incision, 1 inch in length, made directly over the vessel as it crosses the lower border of the jaw immediately in front of the masseter. The platysma will need division, as well as the skin and fascia.

The **Temporal Artery** is reached in front of the auditory meatus, and as it crosses the zygoma, through a vertical incision. It is merely covered by skin and fascia, but must be carefully isolated from the auriculo-temporal nerve.

The **Subclavian Artery** has been tied in each part of its course, but most frequently in the third. Ligature of the first part has been so invariably fatal as to warrant us in stigmatizing it as an unjustifiable proceeding, and hence we shall not describe it. The second part may be secured without much risk, the operation being merely a modification of the usual proceeding, and only requiring the scalenus anticus to be carefully drawn aside, special heed being taken of the phrenic nerve.

Ligature of the third part has been performed for axillary aneurism, or hæmorrhage, as a distal operation for aortic or innominate aneurism, and sometimes as a preliminary to amputation of the upper extremity. The patient is placed on the back, close to the edge of the table; the arm is well depressed, and the head turned to the opposite side. The skin is now drawn down by the left hand, and an incision 3 or 4 inches long made over the clavicle (Fig. 80, B). On releasing the skin it retracts upwards, so that the wound comes to be situated about ½ inch above the clavicle, and thus the external jugular vein is more efficiently protected. The centre of the incision should be placed about 1 inch to the inner side of the centre of the clavicle, and should expose the space between the sterno-mastoid and trapezius muscles, the fibres of which are divided to a suitable extent if they abnormally encroach upon the bone. The skin, superficial fascia and nerves, with the platysma, are divided along the whole length of the incision, as also the deep fascia. The external jugular and other veins now come into view, often constituting a plexus, which may give the surgeon much trouble; when possible, they should be gently drawn out of the way by means of blunt hooks, but if necessary they must be divided between ligatures. The cellular tissue is then further incised in the line of the wound, care being taken to avoid the transverse cervical and suprascapular arteries, the former of which is above the line of operation, whilst the latter is hidden behind the clavicle, and should not appear. The posterior belly of the omo-hyoid is clearly defined, and, using it as a guide, the finger can be passed inwards to the scalenus anticus, and thence downwards to the scalene tubercle on the first rib. The subclavian vein is situated in front of the finger, but on a lower level, whilst the artery itself can be detected pulsating under the pulp of the finger between it and the rib. On clearing the vessel a little, the cords of the brachial plexus will be seen above and external to it, the lower cord passing down behind. The needle is insinuated from within outwards, and must be kept very close to the artery to prevent all possibility of including the lowest cord of the plexus. The operation in a thin patient may be exceedingly easy, but in a stout subject, with a short thick neck and high clavicle, the greatest difficulty may be experienced in finding the vessel. The chief dangers arise from wounding the aneurismal sac, the pleural cavity, or the superficial veins, whilst the proximity of the cords of the brachial plexus must not be forgotten.

Collateral Circulation.—*Thoracic set:* Branches of the aortic intercostals and internal mammary *with* thoracic branches of axillary.

Scapular set: Suprascapular and posterior scapular *with* subscapular and its dorsalis branch in the venter or on the dorsum of scapula.

Acromial set: Suprascapular *with* acromio-thoracic.

The **Internal Mammary Artery** (Fig. 80, M) may be exposed and tied by dividing the intercostal aponeurosis and muscles about a finger's breadth from the outer edge of the sternum. If the vessel has been divided, and the ends have retracted, it may be necessary to excise a portion of costal cartilage in order to secure both ends—a most necessary proceeding, owing to the freedom of the collateral circulation and the consequent liability to continued hæmorrhage

Ligature of the Vertebral Artery has been undertaken for wounds, for secondary hæmorrhage after ligature of the innominate, and in the treatment of epilepsy, but without much permanent benefit in the last case. The operation, though by no means easy, is usually successful as far as the immediate surgical procedure is concerned. An incision is made along the lower half of the posterior border of the sterno-mastoid (Fig. 80, V), the platysma and deep fascia divided, a few of the posterior fibres of the muscle itself incised if need be, and its belly drawn well forwards. The scalenus anticus muscle is clearly defined, together with the phrenic nerve. The interval between it and the longus colli muscle can now be demonstrated, with the ascending cervical artery lying upon it. The anterior transverse process of the sixth cervical vertebra must be made out. Just below this the vertebral vessels are found entering the canal in the transverse process, and the vein, which is placed anteriorly, is drawn outwards to allow the needle to be passed from without inwards. As a rule, a few sympathetic twigs are included in the ligature, and the resulting contraction of the pupil may (according to MacCormac) be looked upon as satisfactory evidence that the vertebral has been in reality secured.

Ligature of the Thyroid Vessels is sometimes used as a means of arresting the growth of a goitre.

The *superior thyroid artery* is tied by an operation exactly similar to that for the external carotid. The incision along the anterior margin of the sterno-mastoid has its centre opposite the upper border of the thyroid cartilage; the external carotid is defined, and the superior thyroid secured as it rises from it.

The *inferior thyroid artery* is reached by an incision along the inner border of the sterno-mastoid, extending upwards from the clavicle for 3 inches. This muscle and the subjacent carotid sheath are drawn outwards, the sterno-hyoid and -thyroid usually needing to be divided. The transverse process of the sixth cervical vertebra is sought for, and the vessel found passing inwards just below it. It is tied close to the carotid, and as far from the recurrent nerve as possible.

The **Axillary Artery** but rarely needs to be tied, except for punctured wounds, and possibly secondary hæmorrhage from the brachial. For aneurism of the brachial, one would nowadays prefer the operation of extirpation if compression fails. Two classical operations are described and practised in classes on operative surgery.

1. *Ligature of the first part of the vessel* is undertaken through a curved incision, with its concavity upwards, extending from the coracoid process to within 1 inch of the sterno-clavicular joint, and ½ inch below the clavicle (Fig. 80, C). The clavicular origin of the pectoralis major is divided, and the costo-coracoid membrane exposed, reaching from the upper border of the pectoralis minor to the clavicle. Sundry branches of the acromio-thoracic axis may be divided in this proceeding, and tied, and the trunks are then carefully traced backwards with a director and forceps to the main vessels, keeping as far as possible to the lower border of the subclavius. The vein lies within and below, and the cords of the brachial plexus above and to the outer side. The needle is passed from below upwards. The divided muscular fibres should be subsequently sutured together.

Guthrie recommended that the vessel should be tied through an incision in the course of the artery dividing the pectoralis major, and certainly for a punctured wound this is the most desirable proceeding, as any part of the vessel can thus be reached.

2. *Ligature of the third part of the artery* is performed from the axilla. The arm is fully abducted, and the surgeon stands between it and the body. An incision is made in the course of the vessel at the junction of the anterior and middle thirds of the space between the anterior and posterior axillary folds (Fig. 82, A). The inner border of the coraco-brachialis muscle is clearly defined, and forms the first rallying-point; it is drawn slightly outwards, and the median nerve, with the musculo-cutaneous trunk, at once comes into view. On drawing these inwards, the artery itself is seen, with the vein to the inner side, together with the internal cutaneous nerve. The needle is passed from the vein.

Collateral Circulation.—If above the acromio-thoracic, the same as for the third part of the subclavian (*q.v.*).

If above the subscapular and circumflex: Long thoracic and intercostals *with* thoracic branches of subscapular; suprascapular and posterior scapular *with* scapular branches of subscapular; suprascapular and acromio-thoracic *with* posterior circumflex in the deltoid.

If below the circumflex, same as for ligature of brachial above the superior profunda—*i.e.*, posterior circumflex *with* superior profunda in the deltoid.

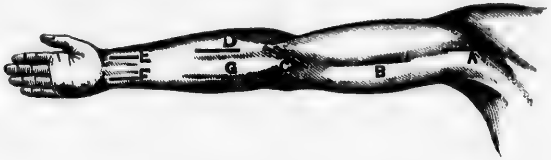

FIG. 82.—INCISIONS FOR TYING THE ARTERIES OF THE ARM.

A, Third part of the axillary; B, brachial; C, brachial at the bend of the elbow; D, upper third of radial; G, middle third of ulnar; E and F, lower thirds of radial and ulnar.

The **Brachial Artery** may need to be ligatured for hæmorrhage from the palmar arches, or from a wound in the forearm or about the elbow, for aneurisms, or for arterio-venous wounds at the bend of the elbow. It may be tied in one of two places:

1. *At the Middle of the Upper Arm.*—The arm is held away from the side at a right angle, with the hand supine, but with no support beneath it. The surgeon is either placed between the arm and the trunk, or may stand above the arm and bend over it to operate. An incision 2 inches long is made in the line of the vessel along the inner border of the biceps muscle (Fig. 82, B), and the thin fascial investment of the limb divided. The inner edge of the muscle is clearly exposed, and by drawing it slightly forwards the median nerve is brought into view, and perhaps the basilic vein. The nerve, which is at this spot crossing the artery from without inwards, is drawn aside, and the sheath of the vessel found beneath it. The artery is separated from its venæ comites, and the ligature passed and tied.

The operation is by no means always an easy one, as there are many traps into which the beginner may fall. Thus the median nerve may cross behind the vessel instead of in front of it; the basilic vein may lie over its situation, and be mistaken for it; or there may be a high division, and two trunks, usually lying close together, must then be sought for instead of one. The most common mistake consists in not recognising the biceps muscle, and in seeking for the artery behind its proper situation.

2. *At the Bend of the Elbow.*—An oblique incision is made, about 2 inches long, parallel to the inner border of the biceps tendon, and the centre corresponding to the fold of the elbow (Fig. 82, C). The wound should be placed at about an angle of forty-five degrees to the axis of the limb, and to the outside of, and nearly parallel to, the median basilic vein, which, if seen, must be drawn inwards. The bicipital fascia is now incised, and the artery with its venæ comites exposed in the loose fat, the median nerve being well away on the inner side. The needle is passed from within outwards.

Collateral Circulation.—If above the origin of the superior profunda, posterior circumflex in deltoid *with* ascending branches of superior profunda.

If below the origin of the inferior profunda, the anastomoses around the elbow-joint.

The **Ulnar Artery** rarely needs ligature except for palmar hæmorrhage or direct wounds. In the former case the artery can easily be secured just above the wrist, in the latter case by enlarging the original wound. The following stereotyped operations are described, but are more often seen in the examination room or dead-house than in the operating theatre. It should be borne in mind that the line of the artery is from the centre of the bend of the elbow to the radial side of the pisiform bone.

1. *At the Wrist.*—An incision about 1 inch in length is made directly upwards from the flexure of the wrist in the line of the vessel (Fig. 82, F). The deep fascia is opened; the tendon of the flexor carpi ulnaris drawn to the inner side, and the vessels are then seen, accompanied by the nerve which lies to the ulnar side of the artery. If possible, the venæ comites should be separated, and not included in the ligature. The aneurism needle may perhaps be passed from within outwards, but this is a matter of no special importance in dealing with such a superficial vessel.

2. *In the Middle of the Forearm.*—An incision is made along a line drawn from the anterior edge of the tip of the inner condyle to the radial side of the pisiform bone (Fig. 82, G). The white line indicating the intermuscular septum between the flexor carpi ulnaris and flexor sublimis digitorum is then sought for and opened up; it is often very slightly marked, and may be difficult to distinguish. If the correct interspace has been opened, the surgeon is directed towards the ulna, and readily finds the vessels under cover of the flexor carpi ulnaris, with the nerve lying a little way to the inner side. The most common mistake consists in getting too far to the radial side, and in separating various portions of the flexor sublimis, or in passing between it and the palmaris longus. Occasionally, even when the correct interspace has been entered, a beginner may pass beyond the vessels, and find himself between the flexor carpi ulnaris and the flexor profundus.

The extreme upper limit of the ulnar artery can also be reached through an oblique incision extending along the upper border of the pronator teres, thus opening up the space in front of the elbow (ante-cubital fossa), and exposing the bifurcation of the brachial.

The **Radial Artery** will require ligature under similar circumstances as the ulnar. The line of the vessel extends from the middle of the bend of the elbow to the interspace at the wrist between the flexor carpi radialis and the supinator longus. It then turns outwards, and may be felt beating in the space described by French anatomists as 'la tabatière' (or snuff-box), between the tendons of the extensor primi and secundi internodii muscles.

1. *At the Back of the Wrist* the vessel may be secured by opening up the above-mentioned intertendinous hollow, where the artery is found coursing onwards to the base of the first interosseous space. An oblique incision is made between the tendons, extending from the back of the styloid process of the radius to the base of the first metacarpal bone. The radial vein is found superficially beneath the skin, and a few twigs of the radial nerve. A deeper layer of fascia is then divided, passing between the tendons, and beneath it the artery is

exposed, crossing the incision obliquely. The surgeon must be careful not to open the synovial sheaths accompanying the tendons, or some stiffness of the movements of the thumb may result.

2. *Above the Wrist*, a vertical incision is made in the line of the vessel (Fig. 82, E), which is found after division of the fascia between the supinator longus and flexor carpi radialis. The radial nerve has passed to the dorsum ere this, and if any nerve filaments are seen they are derived from the external cutaneous. A small superficial vein usually lies over the artery.

3. *In the Middle or Upper Third of the Forearm* an incision is made in the line of the vessel (Fig. 82, D), and the inner border of the supinator longus muscle sought for and retracted. The vessels are found under cover of this structure, with the radial nerve to the outer side, though separated by an interval above.

Ligature of the Abdominal Aorta has been undertaken in eleven instances for severe primary or secondary hæmorrhage, or for diffuse inguinal or iliac aneurism, when no other method of treatment was practicable. All these cases have proved fatal, though one patient operated on by Monteiro in South America survived till the tenth day. It has not been performed since the introduction of strict antisepsis; and inasmuch as the fatal issue was in most instances evidently due to septic contamination of the wound and secondary hæmorrhage, and as the operation has certainly been successful in animals, it is possible that we may yet be able to chronicle a satisfactory result as a triumph of modern surgery.

Two distinct plans of operation have been followed, viz., the trans-peritoneal, and the extra- or retro-peritoneal. The latter method, performed through a lateral incision on the left side, reaching from the tip of the tenth rib downwards, and involving the stripping forward of the peritoneum and its contents, is both difficult and dangerous; and inasmuch as we need not fear opening the peritoneal cavity, there now remains no occasion for such a complicated dissection. The *trans-peritoneal* operation consists in opening the abdomen through an incision slightly to the left of the middle line, having the umbilicus on a level with its centre. The intestines are retracted on either side, and the posterior layer of the serous membrane covering the aorta carefully divided; there is then no difficulty in passing a ligature around the vessel. Possibly the same precaution to prevent excessive backflow of blood would be advisable as in tying the innominate, viz., to secure one or more of the common iliac trunks in addition; such would in no way interfere with the establishment of the collateral circulation.

The **Common Iliac Artery** extends for a distance of 2 inches from the bifurcation of the aorta opposite the left side of the body of the fourth lumbar vertebra to the front of the sacro-iliac synchondrosis. It may be reached, as the aorta, by two methods, the trans- and the retro-peritoneal.

In the *retro-peritoneal* operation (Mott's method) a curved incision is made through the abdominal parietes similar to that for ligaturing the external iliac, but extending higher (Fig. 83, A). The muscles and fascia transversalis are carefully divided, and the peritoneum with its contents stripped up and held out of the way with a broad retractor. The ureter which crosses the artery is usually carried forwards with the peritoneum. The vessel is now sought for, carefully cleaned, and a ligature passed from right to left (of the patient) on both sides of the body, the vein lying behind the artery on the right side, and behind and internal to it on the left. A similar method, known as Marcellin Duval's operation, may be undertaken through an incision (Fig. 83, B) 5 inches long, which, commencing about 1½ inches from the pubic spine, runs parallel to, and a little way above, Poupart's ligament for 1½ inches, and then is directed at right angles to the ligament towards the umbilicus. After the division of the abdominal muscles the operation is performed in the same way as the above, and is perhaps better inasmuch as the artery lies almost directly behind the incision.

The *trans-peritoneal* plan has already been undertaken with success in a few cases, and will probably entirely supersede all other methods. An incision is made in the median line from the symphysis to the umbilicus (Fig. 83, C), the peritoneum opened, the intestines retracted, the vessel sought for and exposed by an incision through the posterior layer of the parietal peritoneum, and a ligature passed and tied. The operation need not be a difficult one, but the ureter which crosses the artery just above the bifurcation must be carefully avoided.

Collateral Circulation after Ligature of Common Iliac Artery.—Blood reaches the *external iliac* and its branches by means of the anastomoses of the lumbar arteries *with* the circumflex iliac, and of the superior epigastric, lumbars, and intercostals *with* the superficial and deep epigastric. The *internal iliac* and its branches is supplied by the union of (*a*) the lumbar branches *with* the ilio-lumbar; (*b*) the middle sacral *with* the lateral sacral; (*c*) the retro-pubic anastomosis of the two obturator arteries; and (*d*) the communications of the pudic, hæmorrhoidal, and vesical trunks *with* those of the opposite side.

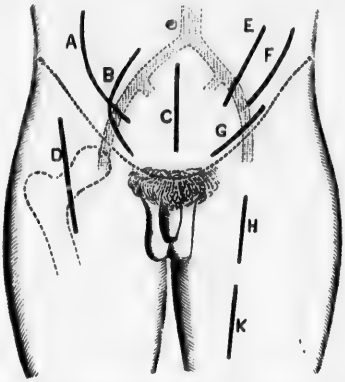

FIG. 83.—INCISIONS FOR OPERATIONS ON LOWER PART OF ABDOMEN AND THIGHS.

A, Mott's incision for tying common iliac artery; B, Marcellin Duval's incision for the same; C, incision for trans-peritoneal ligature of iliac arteries; D, incision for excision of hip by the anterior method; E, inguinal colotomy; F, Abernethy's modified operation for ligature of external iliac; G, Astley Cooper's incision for same; H, ligature of femoral artery at apex of Scarpa's triangle; K, ligature of femoral artery in Hunter's canal.

Ligature of the Internal Iliac Artery is occasionally performed for hæmorrhage from, or aneurism of, one of its branches, the gluteal being that most commonly affected, and lately has been recommended as a means of diminishing the size of an enlarged prostate. The trunk is a short one, at most 1½ inches in length, and is best reached by opening the abdomen in the middle line below the umbilicus, pushing aside the intestines, and searching for the bifurcation of the common iliac. The posterior layer of the peritoneum is then carefully incised, the ureter avoided, and an armed aneurism needle passed without wounding the vein.

The **Collateral Circulation** is the same as that given for the internal iliac division of the common iliac.

The **Gluteal Artery** occasionally needs to be secured at its point of emergence from the pelvis through the upper part of the great sacro-sciatic foramen. This spot is indicated by the junction of the inner and middle thirds of a line drawn from the posterior superior iliac spine to the top of the great trochanter. An incision is made in the direction of this line, *i.e.*, along the fibres of the gluteus maximus, which are separated and held apart. The deep fascia beneath this muscle is then opened up, and the space between the gluteus medius and pyriformis defined. Through this the upper margin of the sacro-sciatic notch can be detected, as also the pulsation of the artery. The vessel must be secured as deeply as possible on account of its early division. It is always a troublesome dissection, and possibly in most cases it would be wiser to secure the trunk of the internal iliac.

The **Sciatic and Pudic Arteries** seldom require to be tied, but may be reached opposite the ischial spine, at the junction of the middle and lower thirds of a line drawn from the posterior superior iliac spine to the tuber ischii. An incision is made over this spot about 5 inches in length, corresponding in direction to the fibres of the gluteus maximus, which are separated and well retracted. The spine of the ischium and lower border of the pyriformis should now be recognised, and the vessels and nerves seen emerging from the foramen. The pudic vessel lies to the inner side of the sciatic; the ligature is passed as high as possible.

The **External Iliac Artery** is probably more commonly tied than any other artery of this magnitude in the body, and if proper precautions are taken, a successful result may be confidently anticipated. The trunk of the vessel measures from 3½ to 4 inches in length; it has but few branches, and those situated low down, whilst it is easily accessible in any part of its course. Its position is indicated by the lower two-thirds of a line drawn from the bifurcation of the aorta to midway between the anterior superior spine and the symphysis pubis, *i.e.*, to a point a little internal to the middle of Poupart's ligament.

Many suggestions as to the best means of reaching the artery have been made, and both trans- and extra-peritoneal methods have been adopted. It is so readily secured, however, by the latter that it seems unnecessary to open the peritoneum. There are two chief forms of extra-peritoneal operation:

Astley Cooper's Operation.—An incision is made parallel to the outer half of Poupart's ligament, commencing a little to the inner side of its centre, and ¾ inch above it, *i.e.*, over the internal abdominal ring, and extending upwards and outwards to about 1 inch internal to the anterior superior spine (Fig. 83, G). The external oblique aponeurosis is divided along this line, and the exposed lower margins of the internal oblique and transversalis muscles arching over the inguinal canal are drawn upwards by retractors. The transversalis fascia and loose subperitoneal fat are now opened with forceps and director, and the vessel is felt pulsating immediately under the finger. It is very important not to damage either the epigastric or circumflex iliac arteries during this manipulation, since they are most essential factors in establishing the collateral circulation, whilst the circumflex iliac vein crossing the main trunk from without inwards must also be avoided. The needle is passed from within outwards, the ligature tied, and the divided muscular and aponeurotic structures brought accurately together by buried sutures.

Abernethy's Modified Operation is that more commonly performed. The incision, about 4 inches in length, extends from a point 1½ inches within and above the anterior superior iliac spine to just external to, and ½ inch above, the middle of Poupart's ligament (Fig. 83, F). Through this the aponeurosis of the external oblique is divided along the course of its fibres, as also the internal oblique and transversalis. The transversalis fascia is now carefully incised; it varies immensely in thickness, being sometimes well developed, but is occasionally so attenuated as to be scarcely recognisable, and in such cases the peritoneum may unintentionally be opened. In the present day this is an accident of slight importance, the wound being readily closed by a continuous suture, and no harm, as a rule, resulting. The fingers are now introduced into the wound, and the peritoneum and its contents stripped from the iliac fossa, and drawn inwards and forwards, where they are kept out of the way by a broad spatula. In the space thus opened one can see the iliacus muscle covered by its fascia, and to its inner side the rounded outline of the psoas. The vessels lie to the inner border of this, and can usually be readily found, enveloped in a fascial sheath, with the genito-crural nerve coursing over it, and perhaps some lymphatic glands upon it. The artery is separated from the vein which lies to the inner side, and the needle passed from within outwards. If the transversalis fascia has not been properly opened, it is quite possible to strip it up together with the peritoneum, and carry the vessels forwards with it, when they may be found under cover of the spatula.

On comparing the two operations, we are very distinctly in favour of the latter plan. By Cooper's method the artery is tied very close to important collateral branches, whilst but a small portion of the trunk is exposed, so that if that is diseased and unsuitable for the application of a ligature no further choice is possible. In Abernethy's, on the other hand, the vessel is tied well away from collateral branches, and if the exposed portion of the trunk is diseased, the common iliac can be reached and secured without much difficulty by extending the incision upwards. As to the greater tendency to hernia stated to exist in this method, this may have been the case in pre-antiseptic days, when the muscles were not sutured for fear of retaining septic discharges; but careful asepsis, the use of buried sutures, and the possibility of doing without drainage tubes should render such a sequela improbable.

Collateral Circulation.—*Anterior set:* Superior epigastric of internal mammary, lumbar, and lower intercostals *with* superficial and deep epigastric in sheath of rectus.

Posterior set: Gluteal and sciatic *with* internal and external circumflex and first perforating of profunda at back of great trochanter (crucial anastomosis).

External set: Ilio-lumbar and gluteal *with* deep and superficial circumflex iliac and ascending branch of external circumflex.

Internal set: Obturator *with* internal circumflex; and terminal divisions of internal pudic *with* superficial and deep external pudic.

The **Common Femoral Artery** is but rarely ligatured, except as a preliminary measure in amputation at the hip-joint, since the number of branches arising from it is likely to interfere with its sound occlusion. In other circumstances calling for this operation it is better practice to tie the external iliac. It may be reached by a vertical incision over the line of the vessel, extending both a little above and below Poupart's ligament. The superficial lymphatics and veins must be carefully avoided, the cribriform fascia divided, the sheath exposed and opened, and the ligature passed from the inner side.

Collateral Circulation.—*Internal set:* Obturator *with* internal circumflex, and internal pudic *with* external pudic.

External set: Circumflex iliac *with* ascending branch of external circumflex.

Posterior set: Gluteal and sciatic *with* internal and external circumflex, and first perforating; comes nervi ischiadici *with* perforating of the profunda and muscular of popliteal.

The **Superficial Femoral Artery** is indicated by a line drawn from midway between the anterior superior spine and the symphysis pubis, and the tuberosity of the internal condyle, the limb being flexed, abducted, and a little everted. It may be secured at 'the site of election,' *i.e.*, at the apex of Scarpa's triangle, or in Hunter's canal.

Ligature at the Apex of Scarpa's Triangle.—A 4-inch incision is made in the line of the artery, the centre being about 4 inches (or a hand's breadth) below Poupart's ligament (Fig. 83, H). The integument and fasciæ are divided, the inner border of the sartorius exposed, and the sheath found immediately behind this, the muscle being drawn slightly outwards, and the middle cutaneous nerve being perhaps brought into view. A muscular branch to the sartorius may be met with at this spot, and should be separately ligatured. The vein is placed at this spot behind the artery, so that the needle may be passed either way, special care being taken to keep it close to the vessel.

Collateral Circulation.—External circumflex *with* lower muscular of femoral, anastomotica magna, and superior articular of popliteal.

Profunda femoris by its perforating and terminal branches *with* the muscular and articular branches of femoral and popliteal.

Ligature in Hunter's Canal.—An incision 4 inches in length is made along the line of the artery in the middle of the thigh (Fig. 83, K). The internal cutaneous nerve and long saphena vein, if seen, should be drawn aside. The sartorius is exposed by division of the fascia lata, its fibres running downwards and inwards. If the upper part of the vessel is to be tied, the inner border should be looked for, and the muscle itself drawn outwards; whilst if the operation is directed to the lower half, the outer border should be defined, and the muscle retracted inwards. The aponeurotic covering of Hunter's canal is now in view, stretching between the adductor longus and vastus internus; it is incised, and the sheath of the vessel found below it, with the nerve to the vastus internus lying to its outer side, the long saphenous nerve crossing it from without inwards, and the vein passing behind it, to become external lower down. The needle may be passed in either direction, and the ligature should not be placed too low on account of the contiguity of the anastomotica magna. A common mistake made by students in tying this artery on the dead subject is to burrow down along the vastus internus on the outer side of the vessels; this is to be avoided by always keeping close to the under surface of the sartorius until Hunter's aponeurosis is clearly visible.

Collateral Circulation is maintained through the profunda and its branches.

The **Popliteal Artery** may be tied either above, just after it has passed through the adductor opening, or below, in the depths of the popliteal space, but preferably in the former situation. Neither operation is often required.

The *upper part* is reached by an incision on the inner side made when the leg is fully abducted and everted parallel to and just behind the tendon of the adductor magnus (Fig. 84). The internal saphenous vein and sartorius muscle must be drawn backwards, and on opening the deep fascia the adductor tendon is seen and hooked forwards, whilst the semimembranosus which lies posteriorly is kept out of the way by a suitable retractor. The artery is found lying close to the bone, and surrounded with a good deal of loose connective tissue immediately behind the adductor tendon. The vein is usually seen on the outer side, and is here very thick and dense, so that it can in the dead subject be readily mistaken for the artery.

The *lower part* is tied through an incision in the middle line of the popliteal space, dividing the deep fascia, and drawing out of the way the heads of the gastrocnemius muscle, and the internal popliteal nerve. The vein is superficial to the artery, and is found by following the short saphenous trunk. The needle is passed from the inner side.

Collateral Circulation is maintained by the anastomoses around the knee-joint.

The **Posterior Tibial Artery** but seldom requires to be ligatured excepting for hæmorrhage, or on the face of amputation stumps; hence the operations described below are rarely seen away from the dead-house. The line of the vessel is indicated by one drawn from the centre of the popliteal space to midway between the internal malleolus and the inner tuberosity of the os calcis.

1. *In the Middle of the Calf.*—The leg is placed on its outer side, and flexed, and an incision 4 inches long is made a finger's breadth behind the inner

border of the tibia (Fig. 84), dividing the skin and subcutaneous tissues, the long saphena vein and nerve being drawn aside if necessary. The tibial origin of the soleus is thus exposed, and incised directly towards the tibia, until the fibrous aponeurosis on its deeper surface is met with. This having been cut through, the muscle is drawn backwards with the retractor, and the vessels, ensheathed in a deep layer of fascia, are seen lying on the flexor longus digitorum, and with the posterior tibial nerve to the outer side. The venæ comites are separated, if possible, and the ligature passed from the nerve Sometimes the above-mentioned aponeurosis is in the substance of the soleus, and a thin layer of muscular fibres exists on its inner aspect.

2. *In the Lower Third of the Leg.*—An incision is made midway between the tendo Achillis and inner border of the tibia. The skin and fasciæ, including the upper part of the internal annular ligament, are divided, and the vessels seen lying on the flexor longus digitorum, with the nerve behind and to the outer side.

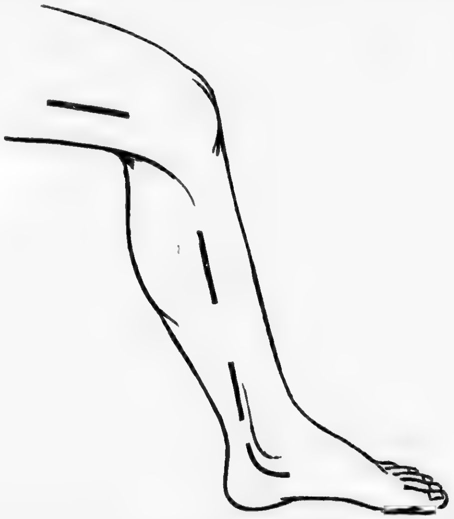

FIG. 84.—INCISIONS FOR LIGATURE OF THE POPLITEAL AND POSTERIOR TIBIAL ARTERIES.

3. *Behind the Malleolus.*—An incision is made about a finger's breadth from the malleolus, curving round its lower border. The deep fascia (or, as it is here termed, the internal annular ligament) is divided over the vessels between the tendons of the flexor longus digitorum and flexor proprius pollicis, and the artery is then readily cleared and ligatured. The sheaths of the tendons should not be opened.

The **Anterior Tibial Artery** is found along a line stretching from a point midway between the tubercle of the tibia and the head of the fibula above, to the central point between the two malleoli below. It may be tied in three situations.

1. *In the Upper Third of the Leg.*—An incision is made exactly in the line of the artery (Fig. 85), and the deep fascia incised. The intermuscular space between

the tibialis anticus and the extensor communis digitorum is opened. The vessel lies between these muscles upon the interosseous membrane, the anterior tibial nerve being to the outer side.

2. *In the Middle of the Leg.*—The same intermuscular space is opened, being indicated here by a definite white line. The vessels lie between the tibialis anticus and the deeply placed extensor proprius pollicis, the nerve usually lying on the artery and needing to be drawn aside.

3. *In the Lower Third of the Leg.*—An incision is made in the line of the artery, reaching upwards for three inches from a point just above the ankle. The deep fascia and upper part of the annular ligament are divided, and the vessel is found ensheathed in a mass of fatty tissue between the tendons of the tibialis anticus and of the extensor proprius pollicis, the nerve lying to the outer side.

The **Dorsalis Pedis Artery** extends from the centre of the line between the two malleoli to the interval between the bases of the first two metatarsal bones. An incision is made in this direction (Fig. 85), the deep fascia opened, and the vessel found placed deeply between the extensor proprius pollicis and the innermost slip of the extensor brevis digitorum. It is by no means easy to find, and for practical purposes the best plan would be to divide the vessel by an incision extending to the bones, and then pick up and tie the bleeding ends.

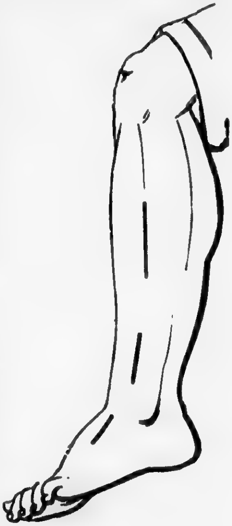

FIG. 85.—INCISIONS FOR LIGATURE OF ANTERIOR TIBIAL AND DORSALIS PEDIS ARTERIES.

The **Peroneal Artery** can be reached through an incision along the posterior border of the centre of the fibula, the leg being laid on its inner side. The outer edge of the soleus is defined and drawn inwards, the lower fibres of attachment to the fibula being divided if necessary. The flexor longus pollicis is thereby exposed, and incised in such a manner as to allow the surgeon to reach the postero-internal border of the fibula; the artery is then readily found lying in an osseo-aponeurotic canal.

CHAPTER X.

VEINS.

Thrombosis.

By **Thrombosis** is meant intravascular coagulation in any part of the circulatory system. Normally the blood remains in a fluid condition, owing to some interaction between it and the vessel walls, the character of which is not yet fully established. Any factor producing a disturbance of this normal equilibrium may determine thrombosis, and any part of the vascular tract may be affected by it, whether the heart, arteries, veins, or capillaries. We have discussed already some of the conditions associated with capillary or arterial thrombosis; what follows, whilst referring primarily to venous thrombosis, is also in a measure true of the other forms.

The **Causes** of venous thrombosis may be arranged under three headings:

(1) *Changes in the vessel walls*, as a result of which the integrity of the endothelium is disturbed—*e.g.*, injury (either division, rupture, puncture, or contusion), inflammation, or degeneration (as in varicose veins).

(2) *Changes in the constitution of the blood*, whereby its coagulability is increased. Excess of excretives, as after pregnancy during removal of the uterine walls, may have this effect, or the presence of toxines or ptomaines arising from bacterial activity. Hence septic diseases are commonly associated with thrombosis. Great loss of blood up to a half of the whole amount in the body also increases its coagulability, but excess of leucocytes, as in leukæmia, has the opposite effect. A. E. Wright has shown that the percentage of calcium chloride in the blood is an important factor. If 0·6 per cent. of this salt is present, coagulation is hastened, and he has proposed to reduce the loss of blood during operations to a minimum by injecting into the rectum half an hour previously a pint of warm water containing in solution 2 oz. of this salt. In one or two cases in which we have seen it used, it appears to have been efficacious, but whether it will be

generally applicable is doubtful, since it might also lead to coagulation in unwished-for localities.

(3) *Diminished rate of the blood stream* will tend to produce thrombosis if some other condition is also present to determine it. Lister showed years ago that blood can remain fluid for a long time if kept in a test-tube formed of a suitable length of a vein wall; but when either of the preceding factors is present, a retardation of the blood stream would materially assist in causing coagulation. Thus, when a vein becomes pressed upon by a tumour, the obstruction to the blood flow produces a clot at the spot where the integrity of the wall is interfered with. After fevers, such as typhoid or rheumatic, where the character of the blood is somewhat altered and the action of the heart is weakened by changes in the muscular fibres, the defective *vis-a-tergo* causes a retardation of the flow in the veins, as a result of which the intravenous pressure is diminished, and the valves are only partially pushed back, spaces being left behind them in which the blood stagnates. Coagulation is probably determined by some slight injury or pressure which is not noticed by the patient, or by some lessened vitality of the wall of the vein, or by disintegration of the leucocytes and setting free of fibrin ferment owing to the defective circulation. The clots thus formed behind the valves gradually increase in size until the whole lumen of the vessel is obstructed. The *white leg* of pregnancy is sometimes induced in the same way, although it is probable that in many cases the coagulum extends to the femoral vein from the uterine plexuses.

The **Character** of the clot varies according to whether it is deposited slowly or is due to a rapid coagulation of the blood. In the former case the so-called **White Thrombus** is met with, which is formed upon, and adheres to, the vessel wall, and gradually increases by fresh deposit of fibrin until it entirely blocks the lumen of the vessel. As to the method of formation of this thrombus many different opinions have been given. Zahn, by experimentally irritating the veins of the mesentery or tongue of a frog, saw the thrombus formed from what he imagined was a collection of leucocytes, which adhered to the injured spot, and after a time losing their definition and outline, were changed into a fibrinous mass. Later researches, however, seem to indicate that the formative elements in a white thrombus are not leucocytes, but the so-called hæmatoblasts of Hayem, or the 'blood plates of Bizzozero,' those minute colourless elements of the blood which only become apparent on special preparation. If a certain number of red corpuscles are entangled in the meshes of the clot, it is termed a **Mixed Thrombus**; the more rapid its formation, the greater the number of red corpuscles present. Should the blood coagulate *en masse* in a vein, as after its total division or ligature, an ordinary **Red Thrombus** is produced, which at first is not adherent to the wall, but becomes so later on, especially at its base. A similar type of clot is usually found post-mortem, capping any white clot which has formed previously.

The **Effects** of thrombosis may be considered as local, distal, or proximal.

Locally, the following conditions may obtain: (*a*) The clot may be organized into connective tissue, a fibrous cord replacing the vessel in the same way as was described for arterial thrombosis in a previous chapter (p. 215). (*b*) The lumen of the vein may be re-established by canalization of the clot, or of the fibrous cicatrix replacing it owing to the dilatation of the vessels contained within, or by cleavage and shrinking of the thrombus to one side of the vein wall. (*c*) The clot may soften, disintegrate, and be washed away in minute particles into the circulation. If this is unattended with sepsis, no harm need follow; but if septic in origin, an abscess may form locally, and from this septic phlebitis may spread along the vein and give rise to diffuse suppuration, together with general pyæmia. (*d*) The clot may shrink or become loosened in an ampulla of a varicose vein, forming a fibrinous mass which may subsequently be infiltrated with calcareous particles, constituting a vein stone or *Phlebolith*.

Distally, congestion of the terminal veins is caused by the obstruction to the circulation, and if a main trunk is affected, œdema of the limb follows, and possibly ulceration or gangrene. In favourable cases the collateral circulation is soon established by the opening up and dilatation of other venous channels, which after a time become somewhat varicose, and if situated superficially are often very prominent and obvious. Thus, if the common femoral or external iliac vein is occluded above Poupart's ligament, the internal saphenous and superficial epigastric veins become distended and varicose, and the latter is seen coursing up the abdominal wall towards the umbilicus, and uniting with the same branch on the opposite side to find its way to the saphena vein of that limb.

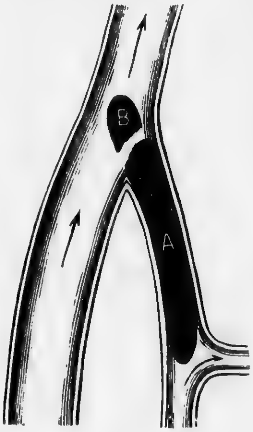

FIG. 86.—THROMBUS AND EMBOLUS. (KEEN AND WHITE.)

A, Thrombus *in situ*; B, embolus detached from the same.

Proximally, the process may gradually extend upwards, and finally involve larger and more important trunks than that in which it originated. Moreover, a portion of a thrombus may be detached as an *Embolus* (Fig. 86, B). If the clot is undergoing molecular disintegration and only minute portions are set free, they are filtered off by the lungs or kidneys, and no symptoms need be caused. If, however, a large portion is detached, urgent symptoms of dyspnœa and even death occur from obstruction to the pulmonary vessels. If the clot becomes septic and fragments conveying organisms are carried into the circulation, pyæmia is the result, being, however, preceded in the portal area by pylephlebitis—*i.e.*, suppurative phlebitis of the portal trunks in the liver.

The **Clinical Signs and Treatment** of venous thrombosis are the same as for phlebitis (*q.v.*).

Embolism.

An **Embolus** is the term applied to any foreign body which travels for a greater or less distance in the bloodvessels until it becomes lodged within them and causes obstruction. There are four main varieties of embolus met with in practice: (*a*) **Simple Emboli**, *e.g.*, blood-clot, granulations or fibrinous vegetations from the cardiac valves after acute endocarditis, atheromatous plates, air-bubbles (p. 230), fat globules (p. 363), etc. (*b*) **Infective Emboli** consist of either zooglœa masses of bacteria or disintegrated portions of blood-clot carrying micro-organisms and originating a pyæmic abscess wherever they lodge. (*c*) **Malignant Emboli** are formed by portions of some malignant growth, from which the various secondary deposits originate; such are met with more frequently in the sarcomata than in the carcinomata. (*d*) **Parasitic Emboli** also occur, such as the ova and scolices of the *Tænia echinococcus*, and the *Filaria sanguinis hominis*.

Emboli may be detached from the heart, veins, or arteries, although necessarily they are never arrested in a systemic vein, but only in the arteries or portal vein. They are of all sizes, and the character of the resulting symptoms depends much on this. A large embolus started in a peripheral vein usually lodges in one of the branches of the pulmonary artery, and may cause instant death; a smaller one is arrested in one of the terminal arterioles of the lung, whilst minute ones will very possibly pass through the pulmonary capillaries, and become impacted in the systemic vessels.

Effects of an Embolus.—The **Local** effects of the lodgment of a simple embolus consist, firstly, in the deposit of fibrin upon it, rendering the obstruction complete as far as the first collateral branch; organization of the thrombus usually follows, although occasionally it may disintegrate and disappear. Under these circumstances a weak spot may be left in the arterial wall, from which an aneurism is subsequently developed. The local effects of infective, malignant, and parasitic emboli are dealt with elsewhere.

The **Distal** effects of embolic obstruction depend entirely on the relation of the vessel blocked to the surrounding circulation.

(1) Should the embolus be lodged in an artery which gives off anastomotic branches between the point of obstruction and the final capillary circulation, a **transient anæmia** is all that will occur in most cases. If the artery is small, or goes to unimportant structures, no symptoms need arise from this; but if the vessel is large, or supplies delicate and important tissues, serious results may follow even a temporary arrest of the circulation; thus, embolus of the central artery of the retina always causes permanent blindness, although the retina still lives.

(2) Should the embolus block what Cohnheim calls a 'terminal artery' (*i.e.*, one with no anastomosis between the embolus and the terminal capillaries), or a vessel with insufficient collateral circulation, and should the veins from the part be valved so as to prevent reflux of blood, the obstruction will lead to **death** of, at any rate, a portion of the anæmic region—*e.g.*, gangrene in a limb, or white or yellow softening in the brain.

(3) Should a terminal artery be blocked and venous reflux be possible, the temporary anæmic area soon becomes engorged with blood to such an extent as to lead to extravasation, and a firm solid patch of a dark red colour, wedge-shaped, and with its apex towards the embolus, known as a **hæmorrhagic infarct**, results. In soft tissues, such as the brain, venous regurgitation of this type results in destruction of the affected part, which comes to resemble an apoplectic clot; but in firmer structures the infarct forms a solid mass undergoing various reparative changes, which result in the formation of a depressed cicatrix containing a few hæmatoidin crystals. The conditions necessary for the production of an infarct are met with in the spleen, kidney, brain, and certain branches of the pulmonary artery; in the liver the anastomosis is generally too free to allow of its formation, although it has been known to occur.

Effects of the Lodgment of Emboli on Various Organs.

In the **Brain**, the middle cerebral artery is most commonly blocked, resulting in immediate hemiplegia, which may be almost entirely recovered from, but commonly leaves some impairment of function. In children the symptoms are less marked, but aneurism of the affected vessel occasionally follows. In the **Central Artery of the Retina**, sudden total and irremediable blindness is produced; the branches of the vessels are seen to be almost empty, the retina becomes œdematous, the macula alone retaining its normal colour, being seen as a cherry-red spot, contrasting markedly with the pallid œdematous tissues around. Vision is never restored. In the **Lung**, fatal dyspnœa results from obstruction to a large vessel; whilst, if a smaller one is blocked, a certain amount of pain and dyspnœa is produced, followed by the formation of an infarct, as indicated by dulness, bronchial breathing, and bronchophony. In the **Liver**, an embolus of the hepatic artery causes sudden hypochondriac pain, and perhaps a passing glycosuria. The portal vein is also sometimes the site of an embolus, which is, however, usually of a septic nature, and gives rise to pyæmic symptoms (pylephlebitis). In the **Spleen**, a sudden pain in the left hypochondrium is noticed, the organ becomes enlarged, and a considerable rise of temperature may follow. In the **Kidney**, sudden pain in the loin and a temporary hæmaturia constitute the main effects. In the **Intestine** localized ulceration or extensive gangrene is likely to follow, according to the size of the vessel obstructed. In the **Limbs**, the emboli usually lodge at the bifurcations of main vessels, often saddling across the fork, and obstructing both branches. Sudden pain may be felt at the spot, shooting downwards, and either recovery or gangrene ensues (p. 68).

Phlebitis.

Phlebitis, or inflammation of the vein wall, may arise from a variety of causes, and is not uncommon in surgical practice. The following forms may be described:

1. **Simple Phlebitis**, in which a more or less *localized* inflammation of the wall of a vein is attended by thrombosis; it extends for a variable distance up and down the vessel, but usually not further than the next patent branches. (*a*) It may arise from *injury*, either subcutaneous or open, or from the continued irritation of a tumour or aneurism; (*b*) it may be *idiopathic* in nature, and then usually attacks the larger veins of the lower extremity, or vessels which have been long subject to varix, especially in gouty individuals. The blood usually clots first in one of the pouches or ampullæ, or behind a valve. (*c*) It may also follow as a sequela of primary thrombosis; or (*d*) it may be induced by an inflammation of the tissues around the vein (*periphlebitis*), usually of septic origin.

2. **Infective Phlebitis** is a much more serious condition, inasmuch as the thrombus resulting therefrom is always invaded by micro-organisms, and the disease is often of a *spreading* type. It was this form of phlebitis which in the old days so commonly followed operations, and made surgeons fear any interference with veins; it has now been almost banished as a sequela of surgical operations by antisepsis, and there is no more fear of dealing with veins than with any other tissue of the body. It may, however, arise (*a*) in traumatic cases where asepsis has not been attended to or has failed, the organisms invading the clot which lies in the open mouth of the vein; or (*b*) as a result of septic periphlebitis, as in wounds, or more commonly in septic inflammation of bones, such as when a septic mastoiditis leads to disease of the mastoid emissary vein and of the lateral sinus. The usual results are localized or spreading suppuration in the course of and around the vein, and general pyæmia. (*c*) It may also be induced by auto-infection of the clot present in simple phlebitis.

The **Morbid Anatomy** of phlebitis shows nothing unusual; the walls of the vein are congested and thickened, and the endothelial lining hypertrophied; the thrombus contained in the vessel is in one of the conditions described under thrombosis. If infected, the clot becomes soft and disintegrated, resembling dirty-looking pus; a localized abscess may form, and the suppuration extends for some distance along and around the vein. In the more favourable cases the spread of the infection may be limited by the terminal portions of the clot remaining firm and unaffected.

The **Symptoms** of inflammation of a **superficial** vein are sufficiently obvious. The vessel becomes swollen, hard, and painful, with localized enlargements or knobs corresponding to the valves, or to the pouches in varicose veins. The skin over them may be dusky and congested, and there may be some œdema of the region from which the blood flowing in the vein is gathered; this, however, rarely amounts to much, as collateral circulation is always abundant. If suppuration occurs, the signs of a localized abscess are noted; on opening this, care must be devoted to maintaining the part aseptic in order to prevent, as far as possible, the occurrence of spreading inflammation and pyæmia.

When the **deeper** veins are involved, it may be impossible to detect them on palpation, but the acute deeply-seated pain and marked œdema are characteristic evidences of what has occurred. The œdema is of a more or less solid character, similar to what is seen in 'white leg,' in which probably lymphatic obstruction plays a part. Occasionally there is marked swelling of the whole limb, but without subcutaneous œdema. Obliteration of the vessel, and any of the local, distal, or general processes detailed under thrombosis (p. 292) may result.

The onset of **Septic Spreading Phlebitis** is marked by fever and rigors, whilst the local signs are more severe, and the œdema is more extensive, and more rapid in its onset.

Treatment of Simple Phlebitis.—The limb must be kept absolutely at rest to limit the inflammation, and to prevent the detachment of emboli, and also elevated to assist venous return. Locally hot belladonna fomentations may be applied, or the parts may be painted with glycerine and extract of belladonna, swathed in a thick layer of cotton-wool, and lightly bandaged. The patient should be kept on an unstimulating, though nutritious, diet, and the general health attended to. When every sign of inflammation has subsided, and sufficient time has been allowed for the absorption or organization of the clot (six to eight weeks), massage may be commenced, to assist in the removal of œdema and local thickening, and an elastic bandage may be serviceable in restoring the circulation. If abscesses form, they must be dealt with antiseptically.

Symptoms of **Spreading Septic Phlebitis** should be treated, if possible, by placing a ligature between the disintegrating clot and the heart, and scraping or washing out the septic mass; thus in septic thrombosis of the lateral sinus, following suppuration in the middle ear, the internal jugular vein should be ligatured, the lateral sinus opened, and the clot removed. Of course, such treatment is only feasible in cases where a single trunk is affected.

Varicose Veins, or Varix.

A vein is said to be varicose, or in a condition of varix, when it has become permanently dilated, with thickening and more or less tortuosity of its walls. The superficial veins of the leg, especially the internal and external saphena, are those perhaps most commonly affected; the spermatic veins are often in a similar condition, constituting what is known as a varicocele (Chapter XXXVII.), whilst piles are primarily due to varicosity of the inferior hæmorrhoidal veins (Chapter XXXIII.). We shall here only deal with the first of these three manifestations.

Causes.—Varix is induced by any condition which leads to a frequently repeated or more or less permanent distension of a vein, such as prolonged standing, as in those serving behind counters; the pressure of tight garters, especially if worn below the knee; prolonged or forcible exertion of the limb, as possibly in cyclists, whereby the blood is driven from the deeper into the more superficial veins; the pressure of a pregnant or displaced uterus, or of a pelvic tumour; or obstruction to and occlusion of the deeper veins. Any abnormal communication between an artery and a vein also causes varicosity, from the inability of the latter to withstand the arterial blood pressure (*vide* Aneurismal Varix, p. 238). Moreover, chronic constipation often hinders the return of blood from the lower limbs, whilst inherited weakness, or the relaxation of system due to sedentary habits, must also be looked on as predisposing causes. The tendency to varix increases with age till the middle period of life is reached.

When a vein has become varicose, and its walls thickened, the valves become incompetent, and the whole superincumbent weight of the blood tends in the lower extremity, by the force of gravity, to still further increase the mischief.

Morbid Anatomy.—To the naked eye a varicose vein in an early stage appears thickened, distended, and tortuous; as a rule, the walls are so thick that the vein when cut across does not collapse, but presents a gaping mouth; the valves shrink and atrophy, thus becoming functionally useless. After a time the walls become further stretched and irregularly expanded, forming pouch-like dilatations, which become very obvious under the attenuated skin, to which they are often adherent. In many of these cases the walls of the distended veins become exceedingly thin and easily rupture. Microscopically, the change consists in a transformation of the normal structures of the vein wall into fibro-cicatricial tissue. The tunica media is mainly affected, most of the muscular fibres disappearing, whilst the tunica intima is but little changed, and the adventitia thickened. In the pouches the middle coat is atrophied, and, indeed, is often completely absent.

Clinical History.—The enlarged veins are seen ramifying under the skin with a more or less tortuous and serpentine course (Fig. 87), and often feel thickened. One or more veins may be affected, and the tortuosity may be at parts so marked as to constitute large clusters of dilated vessels, which look bluish under the attenuated skin. Occasionally the smaller vessels are mainly implicated, and then great numbers of them may be involved.

The **Effects** of this condition are very varied. The circulation in the lower parts of the leg may be impaired, especially that of the skin. The limbs feel heavy and painful, and after standing or exercise there is usually a little œdema of the ankles. Congestion of the skin often follows, appearing as minute reddish punctæ, corresponding to the papillæ; these subsequently run together and form brownish patches of pigmentation. Eczema is frequently induced by the irritation of these, as by rough and coarse trousers or dirt, and may terminate in actual ulceration. Any lesion, such as a scratch or abrasion, instead of healing readily under a scab, tends to spread and form an ulcer. Injury to the vein may lead to thrombosis and spontaneous cure, but coagulation sometimes occurs idiopathically in the pouches, and the clot may subsequently shrink and form a small fibrinous or calcareous mass, known as a 'phlebolith.' Gouty persons with varicose veins are especially prone to attacks of phlebitis. Occasionally the dilated pouch of a varicose vein gives way, and an alarming gush of blood results; the same may occur from the extension of ulceration through the vein wall. The blood under these circumstances is derived, not only from the lower, but also from the upper end, inasmuch as the valves have become incompetent; a column of blood extending from the right auricle is thus tapped near its lower end, and, unless prompt precautions are taken, the patient's life may be lost.

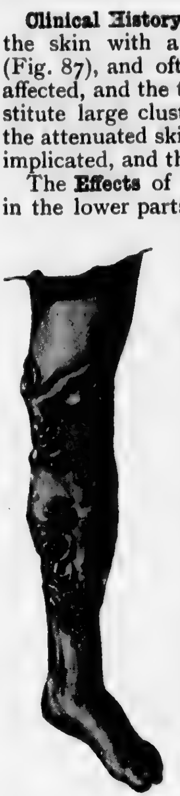

FIG. 87.—VARIX OF INTERNAL SAPHENA.

The **Treatment** of varicose veins may be described as palliative and radical.

Palliative Treatment consists in removing any source of obstruction in the shape of tight garters, in limiting the amount of standing, and in the application of either an elastic stocking or an indiarubber bandage. The bowels should be kept well open, and the general health attended to. Eczema may be treated by the application of soothing and drying ointments, *e.g.*, ung. zinci benzoatis; or if the skin is chronically infiltrated and thickened, by the use of weak tarry applications, *e.g.*, ol. Rusci (1 part to 4 of vaseline), or of ichthyol (10 or 15 per cent. in vaseline). Varicose ulcers may be treated on ordinary principles, or by Unna's method (p. 57); but repair is often delayed till the veins have been dealt with by operation.

Radical Treatment consists in the excision of the distended veins. It may not be practicable to remove them entirely, but if the largest and most prominent are taken away, the others tend to shrink and disappear. There are two chief plans of doing this: (*a*) Small portions are removed at several different situations. The skin is pinched up over the vein, and incised by transfixion; the vessel is usually bared by this means, but may need a little cleaning. An aneurism needle is passed beneath it, and the vein isolated sufficiently to allow of its being grasped by two pairs of forceps, and divided between. Each end is now freed, and drawn out of the wound as far as possible; it is then ligatured and removed. Probably 2½ inches of vein may be taken away through a 1-inch incision. The wound is sutured without drainage and dressed. (*b*) Large incisions are made, perhaps 6 inches or more in length, through which larger clusters of veins may be dealt with. The wound should not lie over the most dilated parts of the vessel, as there the skin is often thin and unhealthy, but should be curved so as to include as much sound skin as possible whilst crossing the vessels once or twice. When the incision has reached the level of the veins, it is easy to follow them out with the scissors. All collateral branches, especially the deep ones, must be secured, and this, in fact, constitutes the great advantage of the operation, viz., that so many anastomosing channels are obliterated. More recently a simpler procedure has been advocated by Trendelenburg, viz., the removal of a portion of the internal saphena high up, so as to break the weight of the superjacent column of blood. In suitable cases it may be a useful additional measure, but the enlarged vein should also be excised.

Inflamed Varicose Veins are not unfrequently met with, and may result in a natural cure of the condition. The symptoms are those of a superficial phlebitis, and the treatment indicated for that condition should be followed out. In cases where there is much pain it may be justifiable to excise the thrombosed vessels, taking the precaution to first secure by ligature the vein above the clot so as to prevent any risk of embolic detachment. Such cases may be considerably shortened and palliated by this means.

Hæmorrhage from a Ruptured Vein needs prompt and decisive treatment. The bleeding spot should be commanded by digital compression, and the patient laid on the back with the limb elevated, until either a pad of antiseptic dressing can be applied to the wound, or a handkerchief or bandage secured over it. Where practicable, excision of the vein is the best plan to adopt, tying it above and blow.

Nævus.

A nævus is a vascular tumour commencing in the skin or subcutaneous tissues, and consists of a congeries of vessels held together by a certain amount of connective tissue. They are usually of congenital origin, or develop soon after birth. Left to themselves, they may shrink and disappear, but more often they tend to increase in size more or less rapidly. Two main varieties are described:

The **Capillary Nævus** (or mother's mark) occurs in the form of a slightly raised flattened mass, bright red or purple in colour, according to the relative amount of arterial or venous blood present, and with occasionally a somewhat irregular or nodulated appearance, in which larger vessels may be seen ramifying. They merely consist of a mass of capillaries lined with endothelium communicating with a few arterioles and venules, and held together by loose connective tissue. As a rule, they are quite small, not exceeding an inch or two in diameter, but sometimes they extend widely over the face and neck, and are then very superficial in character, and somewhat dusky in colour, constituting the 'port-wine stain.' If cut into, they bleed tolerably freely, but the hæmorrhage is easily stopped by pressure.

Treatment is, as a rule, simple in the extreme. Small superficial nævi can be completely cured by some form of cauterization, such as the application of the electric or actual cautery, ethylate of soda, or nitric acid; in applying fluid caustics, the surrounding skin must be protected by a thick layer of vaseline. In exposed situations electrolysis (*vide infra*) is the best plan to adopt in order to prevent the formation of a scar, but sometimes excision will give an equally good result.

The **Cavernous or Venous Nævus** most commonly involves both skin and subcutaneous tissues, but is occasionally purely subcutaneous. It consists of a more or less prominent swelling, soft to the touch, and easily compressible, but refilling when the pressure is removed. There is no pulsation or bruit, and the mass may be lobulated. If subcutaneous, the skin over it is somewhat bluish in colour, but the mixed forms are dusky red. Occasionally they undergo spontaneous cure from inflammation and thrombosis, and cysts are sometimes found in the centre of a nævoid mass, indicating that a partial attempt at this process has occurred. Total degeneration of a nævus results in the formation of a lobulated fibro-fatty mass containing cysts, somewhat simulating a fatty tumour. Venous nævi consist of a collection of vascular spaces lined with endothelium, some larger like veins, some smaller like capillaries, held together by fibrous tissue. The arterial supply is not very great, and the arteries open directly into the venous spaces without the intervention of capillaries. If left to themselves it is difficult to say what would happen; probably some retrogressive change would occur. In a few rare instances ulceration of the growth has led to serious hæmorrhage.

The **Treatment** is by no means as simple as in the former varieties. The following plans are recommended:

1. **Excision** of the growth should always be adopted where practicable. Cases which in former days were dealt with by strangulation are now treated by this means. The bleeding is never great, even if the nævoid tissue is encroached upon by the knife, and only a few vessels will need to be tied. Circular growths should be removed by elliptical incisions, and a little undercutting will always enable the edges to be easily approximated.

2. **Strangulation** of nævi with ligatures was largely used in the old days, and is even now practised by some surgeons; but it is essentially bad, and has not a redeeming feature. Any nævus which can be cured by strangulation can also be excised; the process is both painful and tedious, and the strangled tissue may become a source of septic infection. The wound remaining after the mass has sloughed away is a large one, and leaves an ugly depressed cicatrix, contrasting most unfavourably with the linear scar following excision. The only use for strangulation is as a temporary measure during injection.

3. In cases where excision is unadvisable and the circulation can be temporarily controlled, the **Injection** of coagulating and irritating fluids may be made use of. Perchloride of iron or pure liquefied carbolic acid are employed for this purpose, preferably the latter. To control the circulation is a most important part of the proceeding, since it prevents the risk arising from the detachment of emboli or the injection of the coagulant into the general circulation. Various measures may have to be employed to attain this end; thus, in a nævus of the tip of the nose the organ should be grasped just below the bones by well-padded dressing forceps; in the forehead, scalp, or cheek, long straight hare-lip needles may be passed under the growth and the mass strangled for the time being with silk; if the growth is a large one, this must be done in segments. A carefully-graduated hypodermic syringe is now introduced into the mass, and drops of carbolic acid injected at many different spots so as to diffuse it through the swelling, the tumour becoming firm and solid in consequence. No acid must be injected close under the skin, or sloughing may be induced. The circulation should be controlled for 10 minutes after the injection has been completed. The mass subsequently becomes swollen and hard, but gradually both swelling and growth disappear together. Any hæmorrhage occurring from the punctures may be arrested by slight pressure.

4. In cases where the circulation cannot be completely arrested, or where excision is impossible, or where it is important to leave no scars or only minute ones, **Electrolysis** may be employed with

advantage. It consists in the passage of a current of high electromotive force through the mass, producing chemical and physical changes in the contained blood. A Stöhrer's battery may be used, or any suitable collection of cells connected in series. Both needles may be inserted into the mass, but perhaps it is wiser only to use one or more needles connected with the positive pole, whilst the negative pole is connected with a large electrode moistened and placed on some indifferent part of the body, such as the arm, back, or thigh. The needle is often with advantage made of iron or steel, since it is usually corroded, and the chloride of iron thus formed acts beneficially in determining coagulation of the blood. The use of the negative pole is more likely to produce scarring, since a caustic sodium compound is formed around it, and this may lead to sloughing of the tissues; the clot, moreover, is loose and spongy, whilst a much firmer coagulum occurs around the positive pole. If the positive pole alone is introduced, a current equal to about 200 milliampères, as measured by a galvanometer, may be passed for 10 or 15 minutes; if both poles are used, a current half this strength is sufficient. An anæsthetic is needed, and the immediate effect should be to make the mass feel hard and firm by the coagulation of the blood; the tumour is subsequently disintegrated and absorbed. The application may require to be repeated several times, and the needles should be freely worked about through the mass. Not uncommonly the child may become pale and faint if the nævus is on the head, probably as an effect of the strong current upon the cerebral centres.

A **Nævo-Lipoma** is the name given to a somewhat rare tumour, in which a fatty element is blended with nævoid tissue. It is usually of congenital origin, or, at any rate, appears early in life, and is probably due to the undifferentiated formative cells of the embryo developing in a twofold direction so as to produce not only fatty connective tissue, but also vessels. It gives rise to a swelling, lobulated and doughy, like a fatty tumour, although it is usually a little denser in texture than the ordinary lipoma. It may be possible to reduce its size by compression, but there is no thrill or pulsation to be detected; a few dilated veins or capillaries are often seen on the surface. According to Erichsen, it is invariably situated on the back, nates, or thigh; but this statement can scarcely be considered accurate, as we have seen it involving the muscles of the forearm, and also situated in the lower leg. The only treatment is excision of the mass.

Venesection.

Venesection or phlebotomy is a means of treatment which has greatly fallen into disuse of late years, but is still occasionally employed with benefit. When a patient is becoming cyanosed, and asphyxia is threatening either (*a*) as a result of pulmonary engorgement from mitral incompetency owing to the heart being unable to drive the blood into the systemic circulation; or (*b*) as a consequence of some accident involving the chest wall and lungs, whereby the blood-aërating surface is so diminished that it cannot deal with the blood reaching it through the right side of the heart, which hence becomes enormously distended and threatens to stop in a condition of diastole; or (*c*) where inflammation of the brain is pending, and the pulse is hard and full; or (*d*) in many inflammatory states in strong, full-blooded individuals—in any of these conditions venesection may be used with advantage.

The median basilic vein at the bend of the elbow is that usually opened, since it is larger than the median cephalic, though placed more directly over the brachial artery, from which it is separated by the bicipital fascia.

Requisites.—A pad of antiseptic wool or gauze; a strip of bandage about 4 feet long; a lancet; a graduated bleeding bowl; and finally a stick or bandage to be grasped by the hand, so as to cause contraction of the muscles, thus compressing the deep veins and distending the superficial ones.

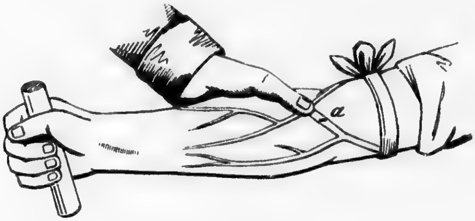

FIG. 88.—VENESECTION.

Operation.—The patient should be seated in a chair; standing would produce syncope too rapidly, whilst the recumbent posture would allow too great an abstraction of blood before Nature's danger-signal (*i.e.*, syncope) is evident. The skin of the elbow having been purified, as also the fingers of the surgeon and the lancet, the pad is placed on the front of the forearm, and the bandage tied firmly over it, so that the venous circulation may be arrested whilst the arterial supply is unimpeded. Grasping the stick firmly causes the veins to stand out. The median basilic is now steadied by the left thumb, and an oblique incision made into it in the axis of the limb (Fig. 88). Blood will flow from it in a full stream, and is collected in the bowl. When sufficient has been withdrawn, the stick is removed from the patient's hand, the surgeon's thumb is placed over the bleeding spot, the bandage above is relaxed, the pad placed over the wound and firmly bandaged in position (Fig. 89); the arm is kept at rest for a day or so to allow the small incision to heal. Occasionally neuralgic pain is caused by the implication of some of the fibres of the internal cutaneous nerve in the cicatrix; whilst, if the lancet is plunged too deeply, an arterio-venous wound may be produced, the consequences of which have been detailed elsewhere (p. 238).

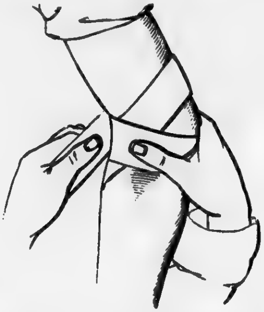

FIG. 89.—APPLICATION OF BANDAGE AFTER VENESECTION.

CHAPTER XI.

DISEASES OF THE LYMPHATICS.

Affections of Lymphatic Vessels.

Acute Lymphangitis, or Inflammation of the Lymphatic Vessels. —The **Cause** is almost invariably the absorption from an impure wound of septic material, with or without bacteria. In either case the toxines diffuse themselves along the lymphatics, and give rise to irritation and inflammation of the surrounding tissues, which may run on to suppuration, especially if pyogenic organisms have also been taken up from the wound. The process is usually limited by the nearest lymphatic glands, which filter off the toxic products, but occasionally it spreads beyond them, and may give rise to general infection of the system. Dissecting or post-mortem wounds are not unfrequently of this nature.

Morbid Anatomy.—The walls of the lymphatics become hyperæmic and infiltrated, and the tissues around are soon involved in the mischief. Suppuration may occur along the lymphatics, or in the glands above. The lymph has been stated to coagulate in the vessels, forming a pinkish clot.

Clinical Signs.—The characteristic appearance is that of fine red lines or streaks following the course of the lymphatics, perhaps up to the nearest glands; the parts thus inflamed are tender and œdematous. If the mischief is limited to the main trunks (*tubular lymphangitis*), these red lines remain isolated from each other; but if all the smaller lymphatic channels of a part are affected (*retiform lymphangitis*), the redness merges into a generalized blush, and the condition is practically identical with cellulitis. Localized foci of suppuration often follow, the redness increasing, and the parts becoming dusky and brawny, until finally the centres soften and fluctuate. These phenomena are associated with the general signs of fever and malaise, the temperature rising to 102° or 103°, possibly attended by rigors, vomiting, and diarrhœa.

The **Diagnosis** of acute lymphangitis from erysipelas turns on the more localized and patchy or streaky character of the redness, whilst the margin is by no means so sharply limited or defined as in the latter disease.

Under suitable treatment resolution rapidly follows, but suppuration may arise either in the glands or in some loose mass of cellular tissue traversed by the lymphatic trunks, or as a chain of abscesses in the course of the vessels. Occasionally the lymphatic vessels become permanently occluded, and a form of solid or lymphatic œdema results. In a few cases the patient dies from general septicæmia, or from exhaustion following diffuse suppuration.

Treatment is first of all directed to the septic wound, which must be thoroughly purified, so as to cut off the supply of irritating toxines to the lymphatics. The limb itself should be kept at rest in a slightly elevated position, and either irrigated with cold lotions, or hot belladonna fomentations applied. Some recommend painting the inflamed area with glycerine and extract of belladonna in equal parts, and then covering it with cotton-wool; the former plans are preferable to this somewhat dirty proceeding, as they enable the surgeon to inspect the limb more freely, and thus ascertain earlier the existence of abscesses, which should be opened as soon as possible. Any subsequent œdema of the limb must be treated by massage and firm bandaging.

Constitutional treatment consists in the administration of a purge, followed by quinine and tonics, care being taken that constipation is not thereby produced. A light and nutritious diet must be ordered, together with stimulants, as may be required.

Chronic Lymphangitis either results as a sequela of an acute attack, or is met with as a separate condition. It is most frequently seen in connection with venereal disease, the dorsal lymphatic of the penis being especially affected, becoming enlarged, hard, and cord-like, especially in cases of primary syphilis. This is usually accompanied by a solid œdematous condition of the prepuce, and swelling of the inguinal glands. Under appropriate anti-syphilitic treatment, the swelling subsides in a few weeks.

Chronic lymphangitis is often associated with, or gives rise to, distension and dilatation of the lymph vessels, or **lymphangiectasis**, which may be met with in a variety of forms.

Congenital enlargement of the lips (*macrocheilia*, Chapter XXII.), or of the tongue (*macroglossia*, *ibid.*), depends on an overgrowth of the connective tissue of the part, associated with chronic distension of the lymphatics.

Lymph Varix is occasionally met with congenitally, involving the superficial vessels. Any part of the surface of the body may be affected by the condition, which manifests itself as a series of small vesicles, which persist and are unaccompanied by any inflammatory redness, thus serving to distinguish it from herpes. They contain lymph, and, if opened, a considerable flow of this fluid (*lymphorrhœa*) may result, lasting for some time. They have been observed most frequently on the inner side of the thigh, and on the prepuce. Treatment consists in laying them open, and cauterizing the base; if the deeper lymphatics are also affected, pressure may be employed.

It is still more or less an open question whether the condition which occurs in children, known as **Congenital Hygroma**, is due to the distension of lymphatic spaces, or arises in the remains of some embryonic tissues. More probably the former is the correct theory. For a description of this condition, see Chapter XXVII.

Sac [illegible] c̄ fluid.

Acquired Forms of Lymphatic Obstruction are liable to result from any conditions which impede the onward flow of lymph in the body. A few cases are on record in which the opening of the **thoracic duct** has been obstructed or compressed. In such the result has usually been a rupture of the receptaculum chyli, with a large exudation of lymph or chyle into the pleural or peritoneal cavities. Turney* reported a case due possibly to the lodgment of a cancerous embolus, in which chylous pleurisy and ascites resulted, but without any apparent rupture of the duct.

The condition known as **Chylous Hydrocele**, in which there is an effusion of milky fluid (presumably chyle) into the tunica vaginalis, is probably due to some such obstructive cause. In a case recently seen by us the lymphatics of the spermatic cord were dilated by a similar fluid in a moniliform manner.

Rupture or division of the thoracic duct during operations on the neck is manifested by an escape of chylous fluid, which coagulates on standing; if the flow continues, exhaustion quickly follows. Keen,† however, has published cases showing that the condition is not necessarily fatal, and that if the wounded vessel can be secured, as by ligature or forcipressure, recovery may ensue. In such instances the thoracic duct probably opens by several mouths into the subclavian vein, and only one of the branches has been injured.

More chronic forms of lymphatic obstruction may arise from the deposit of tubercular or cancerous material in the lymphatic glands, from the continuous irritation resulting from a large ulcer or extensive eczema of the leg, or from the growth within the lymphatics of living organisms, *e.g.*, the filaria sanguinis hominis. The latter condition is the cause of the disease known as **Elephantiasis Arabum**, whilst the former may give rise to a spurious form of this affection, known as **Pseud-elephantiasis.** Three chief phenomena manifest themselves as the outcome of such obstruction, viz., (*a*) *Solid or lymphatic œdema*, a condition in which the subcutaneous tissues become firm, infiltrated, and brawny, but the fluid cannot be expressed from them, as in an ordinary œdema; (*b*) *hyperplasia* follows, affecting not only the subcutaneous tissues, which are markedly thickened and increased in amount, but also the skin, which becomes coarse and wart-like in appearance and structure, and is very prone to ulcerate; and (*c*) *lymphatic fistulæ* are liable to develop, from which a large amount of fluid exudes (*lymphorrhœa*).

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* Trans. Path. Soc., vol. xliv., p. 1.

† Philadelphia Academy of Surgery, April 2, 1894.

The pseud-elephantiasis arising from chronic ulcers, or from disease of the lymphatic glands, can usually be dealt with by the pressure of an elastic bandage; but the limb is very likely to remain permanently enlarged, and in some cases where intractable ulceration and lymph fistulæ exist amputation is the best treatment.

Elephantiasis Arabum (*syn.:* **Barbadoes leg**) requires but little notice here, as it is seldom seen in this country, being mainly limited to the tropics, especially the West Indies and South America. The legs, scrotum, and vulva are the parts most frequently attacked, but the face or breast may also be affected. It manifests itself as a hyperplasia of variable size of the subcutaneous tissues, whilst the skin becomes thickened and wart-like (Fig. 90, A. and B.), and from it a copious discharge of lymph may result. The parts may attain enormous dimensions, the scrotum even reaching to the ground when the patient is sitting. The disease persists for many years, and is not as a rule fatal.

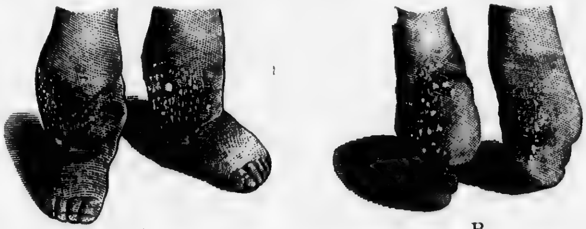
A B

FIG. 90.—ELEPHANTIASIS OF FEET.

The condition in most instances is due, as already mentioned, to the obstruction caused by the development of the *Filaria sanguinis hominis* in the lymphatics. These are spread (according to Manson) by the agency of mosquitoes, in whose bodies the intermediate stage is passed. The dead mosquito, with its parasitic contents, falls upon the water, and in this way the ova find an entrance into the human stomach, where the young worm is set free, bores through the gastric mucous membrane, and finally lodges usually in the peripheral lymphatics of the extremities. Not more than two or three pairs of mature filariæ are generally present in the same individual. The body of the female worm (which attains a length of 3 inches) is mainly occupied by the reproductive organs, and a countless number of embryonic filariæ are produced. Some remain coiled up in the lymphatic spaces, and give rise to the phenomena of lymphatic obstruction. Others become uncoiled, and are then about $\frac{1}{25}$ inch in length; they find their way into the blood stream, usually at night, and can be readily seen by the microscope. Manson claims that they are taken into the body of the mosquito with the blood which it abstracts, and thus a fresh generation is developed.

The **Treatment** varies with the situation of the disease. When the face or trunk is involved but little can be done. When the scrotum is affected, the morbid tissue can be freely dissected away, sufficient skin being left to cover in the wound if possible; the penis and testes must first be dissected out of the mass, and then the scrotum freely amputated, a tourniquet being used to restrain the bleeding. In the leg elastic bandages, elevation, and possibly scarification, may be useful in the slighter cases; but where the limb is enormously enlarged the greatest measure of success seems to have followed ligature of the main artery of the limb, so as to diminish the blood supply, and so check the growth by a process of starvation.

Affections of Lymphatic Glands.

Acute Lymphadenitis, or Inflammation of Lymphatic Glands.—The **Cause** of this condition is almost always the absorption of some irritative material (toxic or infective) from the periphery. When a part becomes inflamed there is always an increased flow through the efferent lymph channels, owing to the exudation; the result of this is an increase in size of the glands to which the lymph is carried, which quickly disappears when the inflammatory process is at an end. If, however, irritating toxines are produced in the inflamed area, they give rise to a more prolonged and serious affection, whether accompanied or not by a similar condition of the lymphatic vessels. When pyogenic organisms are also absorbed, suppuration almost invariably results. In fact, the lymphatic glands must be looked on as the filters by means of which Nature eliminates many sources of disease. It is curious that certain peripheral infective conditions are not at all liable to produce enlargement of the glands, *e.g.*, spreading gangrene, and many forms of cellulitis; possibly the acuteness of the process causes lymphatic thrombosis in the efferent trunks, and thus hinders the absorption of the noxious material.

Occasionally acute lymphadenitis arises without any obvious lesion, being attributed in such cases to strain, as from overwalking; possibly some unnoticed cutaneous lesion is the cause, but in other cases it seems probable that the swelling of the glands is really due to a strain, which may have induced some interference with the flow of lymph. It does not necessarily result in suppuration.

Pathologically, the condition is evidenced by hyperæmia of, and exudation into, the gland, which becomes redder, firmer, and larger than usual. Suppuration usually starts in more than one spot. The capsule becomes involved, and finally yields, whilst peri-adenitis, or inflammation of the surrounding tissues, is always associated with it, even in the early stages; the latter may be of little importance, but if the capsule gives way it may become so extensive as to constitute a diffuse suppurative cellulitis.

Clinically, the signs and symptoms of a localized inflammation are characteristically manifested. The glands can be felt as enlarged, tender, and rounded masses, the skin over them being red and œdematous; and the swelling, which is at first hard and brawny, becomes soft and fluctuating when pus has formed. They early contract adhesions to neighbouring tissues, and suppuration may even extend widely beyond the glands, especially where there is much loose areolar tissue, as in the axilla. Fever, malaise, and all the general phenomena associated with an acute inflammation, are usually well marked.

The **Treatment** consists, in the first place, in the removal of all sources of irritation, both physical and physiological. The part must be kept at rest and protected from injury, and the offending wound or causative lesion dealt with by such antiseptic measures as may be needed to ensure its restoration to a healthy state as quickly as possible. Hot fomentations are applied to the gland, and the patient, after the administration of a purge, may be given quinine and iron, if considered necessary. As soon as pus has formed it should be evacuated by an incision, and the wound dressed antiseptically. Linseed-meal poultices, whilst useful in encouraging the formation of pus, are most undesirable after the abscess has been opened (*vide* Treatment of Acute Abscess, p. 41).

Special Forms of Acute Lymphadenitis.

The **Axillary Glands** are usually affected as a result of poisoned wounds of the hand or fingers, although other glands exist lower down in the arm, *e.g.*, that situated close to the interosseous membrane with the anterior interosseous artery, and the supra-condyloid, just above the internal condyle. Boils in the axilla, and excoriations or septic wounds of the breast may also lead to axillary glandular abscess. In this region a suppurative peri-adenitis is often superadded, extending widely under and between the pectoral muscles, reaching even up to the clavicle. Care must be taken in opening such an abscess to avoid the main vessels by cutting from above downwards, midway between the anterior and posterior axillary folds, whilst Hilton's method should be adopted in all cases where the pus is situated deeply.

In the **Groin** there are three sets of glands: (1) The oblique set, running parallel to Poupart's ligament, and becoming inflamed in affections of the penis, scrotum, perineum, anus, buttock, and lower part of the abdomen;

(2) a superficial vertical set, running with the long saphenous vein, and receiving lymph from all the superficial parts of the limb, except perhaps those from which the blood is returned by the external saphenous vein, the popliteal glands receiving the lymph from this region; and (3) the deep vertical set, receiving the deep lymphatics of the limb, part of which, lower down, have opened into the anterior tibial gland, situated deeply on the interosseous membrane, or into the popliteal group. Abscess in the groin is opened by a vertical incision, so as to allow the wound to gape when the patient sits, and thus any pocketing of matter is prevented.

Suppuration in the glands of the **Neck** is exceedingly common, arising most often from affections of the scalp (eczema or pediculosis), ear (otorrhœa or eczema), throat, or lips. Into the exact distribution of the lymphatics we cannot enter here, but must refer students to anatomical text-books. When opening a cervical abscess, care must be taken to avoid important structures, such as the external jugular vein, and to make incisions across the fibres of the platysma in order to gain space for efficient drainage.

Chronic Lymphadenitis.—Three varieties of chronic inflammation of lymphatic glands are met with, viz., the Simple, Syphilitic, and Tubercular.

1. **Chronic Simple Lymphadenitis** is a condition resulting from some peripheral irritation, which is insufficient to cause an acute attack. It also occasionally results from blows and strains, as in over-walking, being in such cases possibly due to obstruction to the lymphatic flow, owing to compression or rupture of the efferent vessels. The glands become enlarged, tender, and painful, but as a rule they do not become adherent to one another, or to adjacent structures, and show but little tendency to suppurate. This condition often precedes, and, indeed, may be looked on as a predisposing cause of, tubercular lymphadenitis. The **Treatment** consists in keeping the part at rest, removing if possible all sources of local irritation, combined perhaps with the local application of iodine paint, or friction with iodide of potassium or iodide of mercury ointment. The general health should also be attended to, especially in children predisposed to the development of tubercular disease.

2. **Chronic Syphilitic Lymphadenitis.**—The lymphatic glands are involved in several ways in the course of syphilitic disease: (*a*) The primary lesion is associated with the development of an indolent bubo in the nearest lymphatic glands, which become hard and shotty, somewhat like bullets under the skin. But little pain is noticed unless suppuration is taking place; this is never due to the syphilitic virus alone, but to the absorption of some septic matter from the primary lesion. There is usually much more infiltration and enlargement of glands in extra-genital chancres than in those occurring about the genital organs. (*b*) In the second stage, when general infection has occurred, the glands all over the body are affected in the same indolent fashion. (*c*) In the tertiary period the lymphatic glands may undergo a true gummatous change, or become enlarged and tender owing to the absorption of septic material from a broken-down

suppurating gumma. For further particulars and **Treatment**, see Chapter XXXVIII.

3. **Chronic Tubercular Lymphadenitis** is an affection very commonly met with, the nature of which is now much more fully understood than formerly, and in the treatment of which great improvements have been made in recent years.

Causes.—It occurs most commonly in children or young adults, especially in those who have received an inherited predisposition to the development of tubercular disease. Although it may arise in all classes of the community, it is especially prone to occur amongst the children of the poor, whose surroundings are unhealthy, and whose general condition is deteriorated by insufficient or bad food and want of fresh air. Not uncommonly some local focus of irritation is present in the form of pediculosis capitis, chronic otorrhœa, or eczema of the face. As a result of this, neighbouring glands become chronically inflamed, and, as Professor Burdon Sanderson says, 'the soil is thereby prepared for the seed.' The bacilli are conveyed to the gland by the blood or lymph, gaining access through some breach of surface, or perhaps through a healthy mucous membrane. Any lymphoid tissue in the body may become the seat of tubercular disease; but the glands of the neck, especially the submaxillary and the concatenate, are much more commonly involved than any others. The axillary and inguinal glands are also not unfrequently affected, whilst tubercular disease of those in the mesentery gives rise to the affection known as 'tabes mesenterica.'

The course of the case may be artificially described under the following headings, although it must be remembered that they do not necessarily follow one another in exact sequence: (i.) The earliest manifestations of the disease consist in a *fleshy enlargement* of the glands, which cannot at first be distinguished from a simple chronic hyperplasia, either clinically or pathologically. The gland may be enlarged to many times its natural size, and on section looks pinkish in colour, and is of firm consistence. Microscopically, all that is noticed is a great increase in the lymphoid corpuscles together with some overgrowth and thickening of the fibrous capsule and trabeculæ. Occasionally a few multi-nucleated cells may be seen, and around these the usual aggregation of epithelioid cells may be clustered, but the typical gray granulation is not ordinarily present. (ii.) *Caseation* of the tubercular tissue follows sooner or later, any part of the gland being affected. This change, as explained elsewhere, is due partly to the compression of the arteries by the cell proliferation, partly to their lumen being obliterated by a tubercular endarteritis, and partly to the direct influence of the bacilli and their toxines. (iii.) *Calcification* of the caseous detritus may occur in those cases which are tending to recovery. Such is accompanied with a fibroid thickening of the gland, resulting from overgrowth of the capsular and trabecular connective tissue. This change is most frequently observed in the glands within the thorax and abdomen. (iv.) More commonly *suppuration* ensues, sometimes from a simple emulsification of the caseating material, sometimes from a secondary infection with pyogenic organisms reaching the gland from without. Points of pus show themselves at various spots in the glandular parenchyma, and when once formed, these tend to amalgamate and cause the destruction of the rest of the glandular tissue, the fibrous trabeculæ remaining longest unaffected, so that finally the gland is represented by a single abscess cavity surrounded by a pyogenic membrane of the ordinary tubercular type, in which traces of the capsule can be observed. Several of these abscesses may merge into one another, and thus a large multiloculated cavity, containing pus mixed with curdy débris, will be formed. (v.) A certain amount of *peri-adenitis* is almost always met with, though not to any great extent in the early stages; when, however, suppuration has occurred, or if the glands are exposed to pressure or friction, they become adherent not only to neighbouring glands, but also to surrounding structures. In the more chronic forms the fibro-cicatricial tissue thus formed may be so extensive as to render the mass quite immoveable on the deeper parts, such as the main vessels and nerves of the trunk, rendering removal by enucleation almost impracticable. Important vessels may occasionally be eroded by an extension of the suppurative process, and this may lead to fatal hæmorrhage. (vi.) Sooner or later the abscess, if left to itself, bursts either at one or several spots, leaving ulcerated openings, through which may be seen œdematous granulation tissue mixed with caseating material. The edges are undermined, thin, and purplish. The granulations are sometimes very prominent, and may protrude through the openings as fungating masses. A variable amount of pus escapes from these, and this condition may persist for many years if radical treatment is not undertaken. (vii.) Under suitable local and constitutional measures these sores may, and usually do, heal after a time, giving rise to a pulpy spongy *cicatrix*, which is often heaped up and puckered, and which may retain its vascularity for a much longer period than would a healthy scar.

The usual **complications** met with in the course of all tubercular diseases may also manifest themselves (p. 123).

The **Treatment** of tubercular glands is palliative or radical.

Palliative Treatment consists mainly in improving the general health by means of suitable diet and tonics, such as cod-liver oil and syrup of the iodide of iron, together with residence in a healthy, bracing situation, especially at the seaside, as, for instance, at Margate. All sources of local irritation should be removed so as to exclude the advent of pyogenic organisms, and counter-irritants, such as iodine paint, are best avoided. *Rest* of the affected part should be enforced as much as possible; in some cases the application of splints to restrict movement is advisable.

Radical Treatment.—Wherever practicable, glands evidently tubercular should be completely removed by dissection, and even amongst the wealthy too much time should not be wasted in palliative measures, inasmuch as the longer they are left, the firmer will be the adhesions which they are likely to contract with surrounding tissues. In the later stages, so far may this process have gone that removal by dissection is hopeless. In such cases a free opening is made down to the diseased tissues, and as much removed as possible, whilst the remaining deeper parts are scraped with a Volkmann's spoon. In the neck very extensive operations are nowadays undertaken for the removal of tubercular glands. The incision necessarily varies with the situation of the mass, but where feasible it should be kept well behind the sterno-mastoid. Where, however, enlarged glands exist both in front, behind, and beneath the muscle, it is well to make the incision parallel to the course of the external jugular vein, entirely dividing the sterno-mastoid, which may subsequently be stitched together. Special care must be taken of the chief vessels and nerves, and the situation of the spinal accessory nerve as it crosses the posterior triangle must not be forgotten. Naturally adherent glands may be dealt with very much more freely in the posterior than in the anterior portion of the neck.

Tumours of Lymphatic Glands.

Several conditions are met with in which lymphatic glands become chronically enlarged without any signs of inflammation being present, and such are generally considered to present the characteristics of tumours.

The **Primary New Growths** occurring in lymphatic glands are lymphadenoma and lympho-sarcoma. A few instances of apparently primary epithelioma have been recorded. Amongst others, Sir James Paget mentions some cases of epithelioma of the inguinal glands, following eczema of the scrotum, caused by soot, tar, or paraffin, in which, on the most careful examination, no primary scrotal growth was discovered; possibly it had disappeared.

Lymphadenoma is the term given to a new growth occurring in lymphatic glands, corresponding in structure with normal lymphoid tissue—that is to say, it consists of a stroma, more or less delicate according to the consistency of the mass, in the meshes of which are packed a great number of small round cells resembling leucocytes.

There has been much discussion as to the nature of this growth, and also as to the relation it bears to Hodgkin's disease and leukæmia. Nothing final has as yet been made out, but there seems every probability in favour of the view that it is to be looked on as an infective disease, due to some specific micro-organism, and therefore to be placed midway between tubercle and cancer. Occasionally it develops as a strictly local affection, and can then be readily eradicated; sometimes it involves a whole series of lymphatic glands, but is limited to one region of the body, both the above types being included below under the term 'benign' lymphadenoma. On the other hand, it is sometimes disseminated widely throughout the system, either affecting mainly the external lymphoid tissues, and then constituting Hodgkin's disease, or else attacking chiefly the spleen and other internal tissues of a lymphatic nature, such as the bone-marrow, and associated then with blood changes of a leukæmic nature, giving rise to the disease termed 'leucocythæmia.' Although we must admit that there are difficulties in explaining all cases by the above hypothesis, yet it will serve as a useful working theory, and we must look to further investigations for more light on the subject.

Benign Lymphadenoma is usually met with in young adults, affecting either one gland or a large number. It is most often seen in the neck, and though the patient may be slightly anæmic, he never presents any blood changes of the leukæmic type.

When a *single gland* is affected it becomes slowly enlarged, and shows no tendency to caseate or suppurate; it remains free from adhesions to adjacent structures, and is hence moveable and painless. It is quite possible that many glands thought to be of this nature are in reality tubercular, in the early stages of fleshy enlargement. The **Treatment** of such is by removal.

When *many glands* are affected, the disease may be limited to one region; the neck is a favourite situation, both sides being often involved, and the disease may here be so extensive as to render the wearing of collars impossible. The special characteristics of this condition are: that many glands are enlarged, that they have no tendency to suppurate, caseate, or ulcerate, and that there is but little peri-adenitis; hence they are freely moveable one on another and on surrounding tissues, and are neither painful nor tender.

On removal, the glands vary somewhat in consistency, being sometimes firm and elastic, presenting on section with the knife a pink and fleshy cortical portion, whilst the central part is grayish and somewhat indurated; but in other cases they are soft and more friable, and on scraping the cut surface with the knife a milky juice is obtained, the cells of which, however, are leucocytes and not epithelial, as in the juice obtained by scraping a cancerous tumour. This difference in texture depends mainly on the rate of growth, the soft growing rapidly, and the firm slowly. Microscopically, no marked changes in structure from ordinary lymphoid tissue are observed. Constitutionally, there is usually a good deal of anæmia present, but no leukæmia.

This affection is sometimes markedly amenable to **Treatment**, especially to the administration of arsenic. Small doses of liquor arsenicalis combined with iron are at first given, but these are gradually increased, and as the patient comes under the influence of the drug, retrogression of the glands may be observed. If, however, they persist in spite of medicinal treatment, their removal should not be delayed. Where many glands are affected this may involve extensive and repeated operations.

Malignant Lymphadenoma (*syn.:* **Hodgkin's Disease or General Lymphadenosis**) is a condition usually met with in adults, and is characterized by an overgrowth of all, or nearly all, the lymphoid tissue in the body, including glands, the spleen, the solitary or agminated follicles of the intestine, etc. Where the spleen is primarily and mainly enlarged, the disease is often termed 'splenic leucocythæmia,' owing to the fact that in it blood changes of a leukæmic type are present—that is to say, there is a marked increase in the number of leucocytes, whilst the red corpuscles are deficient both in number and in the amount of hæmoglobin contained in them. When, however, the external lymphatics are mainly affected and the spleen not specially so, it is termed 'Hodgkin's disease.' In it the patient is profoundly anæmic, but is not necessarily leukæmic, although the latter change is sometimes met with.

The tumours thus produced grow slowly, are painless, and, when groups of glands are affected, adhere together, forming lobulated masses, but with no tendency to caseate or suppurate. The skin becomes involved in the tumour later on, and superficial ulceration may follow, but there is no subsequent fungation of the growth.

The prognosis is exceedingly grave, the disease usually progressing in spite of all treatment to a fatal issue, which is due to exhaustion. Where leukæmia is present, hæmorrhages into the tissues, or from the mucous or cutaneous surfaces, are often noticed.

Treatment.—Arsenic combined with iron may be administered, and, latterly, injection of an emulsion of bone-marrow has been strongly recommended, but the results gained hitherto have not been at all satisfactory. It is useless attempting to remove the external growths, since they are only an evidence of a deep-seated general affection.

Lympho-sarcoma.—Lymphatic glands sometimes become the seat of a primary sarcomatous growth, the microscopic characters of which have been detailed elsewhere (p. 139). The disease occurs in adults, and is met with not uncommonly in the tonsil, sometimes in the glands at the root of the neck, and may occasionally occur in the mediastinum or in the testis. When commencing in a region where its development can be followed, it is seen to form a rapidly growing tumour, which is at first firm, elastic, and painless; later on, however, as it increases in size, it becomes tender, and may cause great pain from pressure on, or implication of, nerves. It early contracts adhesions to surrounding parts, and gives rise to secondary growths in neighbouring glands by direct transmission. The superjacent skin is at first unaltered in colour and texture, but as the tumour increases, it becomes congested and shiny, and contains a network of dilated veins. Finally, it is involved in the growth, and ulcerates, an occurrence usually followed by the sprouting up of a bleeding fungating mass, similar in character to that formed by any other rapidly growing malignant tumour. Dissemination of the growth throughout the viscera may also be met with, death quickly resulting from exhaustion and cachexia.

The **Treatment** consists in the removal of the mass, where practicable, without delay. If, however, extensive adhesions exist, this becomes absolutely impossible.

Secondary Growths in Lymphatic Glands are a special feature of all cancerous tumours. In the sarcomata they are less common, but are always present in the case of melanotic sarcoma, lymphosarcoma, and usually sarcoma of the testis, tonsil and thyroid. The special characteristics of these are noted elsewhere.

CHAPTER XII.

AFFECTIONS OF NERVES.

Injuries of Nerves.

THE simplest and most common form of injury to which a nerve is liable is a **Contusion**, causing a sensation of tingling or pins and needles, which usually wears off in the course of a few hours. In severe cases variable degrees of loss of power and sensation may ensue, and in hysterical women more or less neuralgia. In patients suffering from gout, syphilis, or rheumatism, a chronic peripheral neuritis is readily induced, often of a somewhat intractable type, and this even occurs in healthy individuals. As a rule, all the treatment needed consists in gentle friction with stimulating liniments.

A nerve may also be **Strained** by any sudden, unexpected or exceptional movement, producing effects identical with those arising from contusions.

Rupture of nerves without an external wound only occurs in connection with severe injuries, such as dislocations or fractures, and even then total division is very rare, the sheath retaining its integrity, although the axis cylinders may have given way. Immediate paralysis and loss of sensation usually follow, and may be permanent, although not unfrequently repair occurs after a time, owing to the sheath remaining intact. The doubt always existing as to the condition of the sheath regulates the treatment which must be followed, viz., one of expectancy. Friction and electricity should be applied to the parts, and only when these have failed should operation be undertaken. Secondary nerve suture under these circumstances is not a very successful proceeding.

Compression of a nerve is usually due to the growth of tumours or aneurisms, or to some displacement of bones, as in fractures or dislocations; or, again, the nerve may be included in the callus formed in the repair of a fracture, the symptoms not appearing till four or six weeks after the injury; or it may be met with in the form of crutch palsy, or as a result of splint pressure, as when the external popliteal nerve is compressed against the neck of the fibula. Those nerves also which traverse bony canals in the skull are liable to pressure as a result of chronic osteitis and condensation of the surrounding osseous tissues. The early symptoms in such cases are those of irritation, *e.g.*, cramp and spasm of muscles, or neuralgic pain; whilst the later ones, due to more prolonged compression, are those of paralysis and anæsthesia, combined sometimes with trophic phenomena. If the compressing cause can be removed, recovery, at any rate of a partial character, follows in time under suitable treatment, such as massage, electricity, and the administration of nerve tonics.

Puncture of a nerve may be associated with severe neuralgic pains, especially in neurotic women. Occasionally a chronic form of neuritis is started, which travels up the limb, and may cause great suffering or impairment of function.

Total Division of a Nerve.—Nerves are not uncommonly cut completely across in open wounds, and it is most important that the resulting phenomena should be fully understood and accurately studied.

The **Immediate Effects** are: (*a*) Total paralysis of the muscles supplied by the nerve; (*b*) complete anæsthesia of the parts supplied by it, which, however, is not necessarily permanent, since sensation may be apparently conveyed by anastomosing trunks, the anæsthetic area passing through gradual stages of partial sensation before recovery is complete. (*c*) Vasomotor paralysis is also produced, resulting in the limb becoming hyperæmic and warmer for a few days, and then subsequently colder and insufficiently supplied with blood. (*d*) The excito-secretory nerves are paralyzed so that glands may lose their functions for a time.

The **Secondary Effects** vary with the character of the nerve injured, and are much more complicated than the former. We must discuss them under five headings:

1. **Changes in the Nerves themselves.**—*Locally*, the two ends retract very slightly, perhaps not more than the twelfth of an inch, and the space thus formed fills with blood, which is quickly absorbed, and replaced by a cellulo-plastic effusion of the usual type. Immediate union has been supposed to occur in cases where total restoration of function has rapidly followed complete division; but, as a rule, a mass of fibro-cicatricial tissue is formed, within which may be found spaces filled with fine nervous fibrillæ coiled up in loops and arising from overgrowth of the axis cylinders from the upper end. After an amputation, most of the divided nerves are found to have developed these typical bulbous ends, whilst in nerves accidentally severed in their continuity a bulbous mass forms on the upper end, which is separated by an interval from the shrunken and atrophied lower end, though occasionally there is a fibrous connection between the two. These bulbs are often the seat of severe neuralgia.

Peripherally, the so-called Wallerian degeneration commences about the fourth day after the accident, in consequence of the separation of the nerve from its trophic centres. It first shows itself in the medullary substance, which undergoes a kind of segmentation, becoming broken up into irregular masses of myeline, and disappears entirely in about a month. The axis cylinders also degenerate and disappear at a somewhat later period, and finally only the sheath of Schwann and the perineural connective tissue remain. The nuclei of the sheath proliferate and form a fibro-cellular mass, which represents the nerves, and has long lost all power of conducting nervous or electric stimuli.

Proximally, degeneration of the medullary sheath occurs, similar to that which is seen in the distal portion, but only extending as far as the next node of Ranvier. It is of but little significance. The axis cylinders grow downwards, as already mentioned.

2. **Changes in the Muscles.**—Complete paralysis of motion necessarily occurs when a motor nerve has been divided, and the muscles involved slowly atrophy, and show signs of degenerative changes. The atrophy is not noticed at first, and is not so rapid as that arising from infantile palsy, since it is simply due to separation from the trophic centres, and not to their destruction. As a result of the paralysis and atrophy, various types of deformity may ensue, owing to a disturbance of the equilibrium normally obtained between opposing groups of muscles. The *electrical* changes, too, are exceedingly important. At first there may be a slight increase of excitability both of the muscles and lower end of the nerve to faradic and galvanic currents, but this is not constantly present. The faradic current rapidly loses its power over the affected muscles, and its effects totally disappear in two or three weeks, whilst the galvanic excitability remains for weeks or months, and even then only slowly diminishes, so that a condition follows in which the galvanic current produces a much greater contraction than the faradic (*i.e.*, 'the reaction of degeneration'). As long as this phenomenon remains, there is a hope that restoration of the continuity of the nerve may be followed by restoration of function; but when the muscles react neither to galvanic nor to faradic stimuli, the case may be looked upon as beyond repair.

3. Various modifications of **Sensation**, both special, general, and muscular, may be met with, in the shape of neuralgia, hyperæsthesia, anæsthesia, etc.

4. The blood supply to a paralyzed part is always diminished, although congestion may result in the lower extremities, owing to the weak circulation; consequently the temperature falls, and the vitality of the part is decreased. This, associated with the loss of trophic influence of the nerve centres, results in certain conditions which may be of considerable importance. Thus the skin may become thin, atrophic, bluish-red, and shiny ('glossy skin' of Weir-Mitchell), or it may be rough and covered with scales, or even œdematous. Chilblains are readily produced, and any exposure to cold or heat may result in vesication or even sloughing.

Wounds heal badly, and ulceration from slight irritants is very likely to occur, *e.g.*, corneal ulceration after division of the fifth nerve, and perforating ulcers of the foot. The cutaneous appendages are also involved, the hairs falling out, the nails becoming rough, brittle, and scaly, and the sebaceous and sweat glands either discharging an abundant secretion, or remaining absolutely functionless. Atrophy of the smaller bones may follow, and ankylosis of the terminal joints of the fingers or toes. In a growing child the development of the part is always more or less impaired.

5. Finally, in a few cases changes have developed in the central nervous system which are of extreme interest. Thus, in the early stages reflex spasms or paralysis are sometimes met with as temporary phenomena; whilst in cases where the irritation of a foreign body is present in addition to the division of the nerve more serious symptoms may result. Thus, in a glass wound of the median nerve, a healthy man treated at hospital developed a typical epileptic fit whenever the neuralgic bulbous end was touched. The bulb was excised, and the nerve cleanly sutured, but without effect, the epilepsy and pain still remaining. The median nerve was divided in the upper arm, and a portion excised, but no benefit was derived from it. Finally, the patient passed into a condition of chronic dementia, and died, no obvious nervous lesions being found on post-mortem examination.

Regeneration of a divided nerve must necessarily ensue if restoration of function is obtained. Nothing certain is known as to the exact nature of this change in the few instances of immediate union which have been recorded; but it appears to have occurred in cases where a free collateral communication existed between the divided end and other nerves. In delayed union, especially when a fibro-cicatricial bulb has formed, and the lower end has atrophied, it is probable that after operation the axis cylinders from the upper segment grow downwards into the lower end, and either set up new action in the sheath of Schwann, whereby new axis cylinders are formed lower down, or they merely extend along the degenerated nerve sheath to the periphery, using it as a scaffolding to direct their onward progress. A medullary sheath is subsequently formed, and the process takes some months to reach completion. Clinically, the earliest evidence of regeneration is a slight return of sensation, which may be at first abnormal, and only slowly becomes of a normal type. Motion is generally much later in its restoration than sensation, and may never be entirely recovered.

The **Treatment** of a divided nerve will depend entirely upon its size and function. If small and of slight importance, no special treatment is called for; but in any of the main nerves of the extremities it is most essential to deal with them at once by **primary nerve suture**. In fact, the same rule obtains nowadays for a divided nerve as for a wounded artery, viz., to cut down and expose both ends, suturing them neatly together. This is best accomplished by using a domestic sewing needle without cutting edges, or a fine Hagedorn's needle, and the finest chromicized catgut; one or more stitches should pass through the nerve, and the rest merely through the sheath. Absolute asepsis is most essential in order to gain satisfactory results.

If the wound has been inflicted months before, and a bulb has formed, **Secondary Nerve Suture** must be employed. The nerve is first exposed by a free incision through the cicatrix, the two ends identified and isolated, and the fibrous tissue of the bulb removed to a sufficient extent to expose healthy nerve fibrillæ in the section; the divided ends are then brought together with as little tension as possible. To supply the interval necessarily resulting from removal of the bulb, traction upon each end of the nerve should be employed to stretch it, and the limb subsequently put up in such a position as to relax the parts, *e.g.*, the wrist flexed to a right angle, or the elbow bent. In one case we removed an inch or two of the humerus to allow the divided ends of the musculo-spiral nerve to be approximated. In order to diminish the drag on the fine end-to-end sutures, a tension stitch should be passed through the substance of the nerve, about ¼ to ½ an inch from the divided ends.

Nerve grafting, in order to bridge over a defect, has not up to the present been found of much practical value, although a few cases of success are reported. A nerve more or less similar in size to that to be operated on is removed from an animal just previously killed, and carefully stitched in position. Probably it merely acts as a carrier to the nerve fibrillæ from the upper end, and possibly the same result would be obtained by passing several fine strands of catgut from one end to the other.

During the time that the paralysis continues the limb itself must be well massaged, the fingers or toes worked daily to keep them from getting stiff, and the muscles treated with electricity to prevent them from degenerating too rapidly. Perhaps the best means of accomplishing this is to use the electric bath, one electrode being placed in a basin of warm saline solution, the other held in the patient's hand or against some part of the back, and the affected limb then dipped in the water till it becomes of a bright red colour.

In many cases where the original wound has been complicated with spreading septic inflammation the impaired mobility is as much due to the inflammatory adhesions of joints and tendons as to paralysis, and this must always be taken into consideration in giving an opinion on a case, or in suggesting treatment.

Inflammation of Nerves.

Acute Neuritis is not a very common condition. It is usually due to injury, gout, or rheumatism, and occasionally found in connection with septic wounds. The nerve may sometimes be felt to be swollen and tender, whilst severe pain of a neuralgic type is often complained of by the patient. On microscopic examination the ordinary signs of inflammation are well marked, though mainly evident in the sheath. The **Treatment** consists of rest to the limb, together with leeching or dry cupping over the course of the nerve, combined with hot belladonna fomentations, and suitable general therapeutic measures.

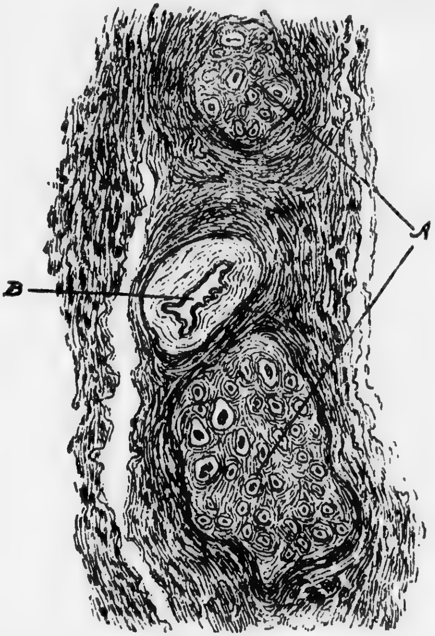

FIG. 91.—CHRONIC NEURITIS, SHOWING INCREASE IN THE AMOUNT OF CONNECTIVE TISSUE, AND THE NERVE FIBRES IN SECTION ALTERED AND COMPRESSED (A), AS ALSO AN ARTERY WITH THICKENED WALLS (B). (PUTNAM.)

Chronic Neuritis, or Perineuritis, is much more common than the former. It is evidenced pathologically by an increase of all the connective tissue of a nerve, both around it and between the fasciculi, with compression of the vessels and nerve fibres (Fig. 91). It may result from injury, such as sprains, strains, or pressure, especially when the patient is suffering from syphilis, rheumatism, or gout. It is very common in the fifth nerve, and in branches of the brachial plexus; and is met with as a peripheral neuritis in various toxic conditions, *e.g.*, alcoholism, diabetes, malaria, etc. The **Symptoms** vary a good deal with the nerve affected. Occasionally it can be felt to be thickened and tender on pressure, whilst more or less severe neuralgia is also noticed, accompanied perhaps with some loss of power in the muscles supplied by it. In a few cases this paresis may be associated with spasmodic contraction of the parts, generally of a tonic type, as in some cases of talipes; but such conditions as facial tic, or scrivener's palsy, where the contractions are clonic, are more frequently due to central changes. Trophic lesions may also be induced, such as perforating ulcer, or ankylosis of the terminal joints of fingers or toes.

The **Treatment** in the early stages consists in the administration of anti-diathetic remedies, and, indeed, iodide of potassium, with or without mercury, is generally applicable. Locally, prolonged rest is needed with counter-irritation in the form of blisters, and later on massage with suitable liniments. If there is any paresis the muscles must be stimulated daily by the faradic current. Excessive pain is combated by administering hypodermically morphia or atropine. Failing these, other means should be adopted, such as acupuncture, in which needles are passed into the substance of the nerve, and allowed to remain for a few moments; this probably acts by relieving the tension and inflammatory exudation within the sheath. Various operative measures dealt with under neuralgia may be called for in severe and protracted cases.

For **Tumours** of nerves, see p. 149.

Neuralgia.

Neuralgia is a condition which either the physician or the surgeon may be called upon to treat; it is exceedingly common, and may be one of the most terrible afflictions to which the human frame is subject. It is characterized by a paroxysmal or intermittent pain of a darting or stabbing character, which follows the course of some particular nerve or nerves, especially the trigeminal. The attack commences suddenly, and the pain steadily increases, until it reaches a climax, and then gradually or suddenly subsides. These paroxysms may last minutes or hours, and may recur at varying intervals, either a few in a day, or many in an hour; they may be induced by natural conditions, or physical phenomena, such as sudden noises, a draught of air, etc. Moreover, pressure over the affected trunks may originate, relieve, or increase the pain, whilst the skin affected by them is often intensely tender, and even hyperæmic and œdematous (the *points douloureux* of Valleix). Occasionally adjacent muscles may become spasmodically and sympathetically contracted during the attack, whilst excessive secretion, such as from the lachrymal or sweat glands, is also induced. Herpes is sometimes met with in the area of distribution of the affected nerve (*e.g.*, shingles in connection with intercostal neuralgia). The fifth cranial nerve is most prone to this affection, but similar manifestations may occur in any purely sensory or mixed nerve, such as the intercostals or sciatic, or in complex bodies, such as the breast or testis, or the larger joints.

The **Causes** of neuralgia are very diverse, and the surgeon often has to look far afield in order to find them. Thus, as *predisposing* causes may be mentioned the hysterical temperament, anæmia, and depressing circumstances of all kinds, especially mental anxiety and worry. The *direct* causes may be toxic, *e.g.*, malaria, lead, or mercury; reflex, *e.g.*, ovarian disease, worms, etc.; central, from disease of the spinal cord or brain; radical, from pressure on the roots of the nerves as they emerge from the spinal canal or cranium; or peripheral, owing to lesions of the nerve-trunks induced either by trauma, inflammation, or new growths.

Treatment consists primarily in attention to the general health, and the local application of counter-irritants and sedatives. Iron and arsenic may be given to anæmic patients; anti-spasmodics, such as valerianate of zinc, to hysterical women; quinine or arsenic for malaria; whilst sea-bathing or change of air is often advisable. Iodide of potassium and mercury are beneficial in all cases due to syphilis. Where the pain is excessive, morphia, even in large doses, may be called for. Empirical remedies, such as antipyrine, phenacetin, and croton-chloral hydrate will also sometimes do good.

When, however, medicinal agents fail, surgical measures are indicated in order to allay the patient's sufferings. The following are the more usual methods adopted:

1. **In purely Sensory Nerves**, such as the trigeminal, simple division or *neurotomy* has often been resorted to, but the relief gained is of a most temporary nature, since sensory nerves readily unite after division, and sensation is rapidly restored even when union is incomplete, probably by transmission through anastomosing branches; hence the operation has fallen into discredit. A much more satisfactory proceeding is *neurectomy* or the removal of a portion of the nerve-trunk, so that union of the divided ends will be less likely to occur. Many of these cases, however, are due to central disease, and it is an interesting question how the trouble can be benefited by such proceedings. Probably the explanation of the relief gained is that the centre is put into a condition of rest

by the exclusion of afferent stimuli. Acting on this theory, most surgeons nowadays endeavour to remove as large a portion of the affected nerve as possible, and Thiersch has suggested a plan of *nerve-extraction* in which he lays the trunk bare at a suitable spot, and then, grasping it with forceps, proceeds to forcibly extract it by torsion, tearing it from its central attachments, and cutting it from the peripheral. The details of the various methods employed on separate nerves are given below.

Finally, if all such measures have failed, the roots of the nerves may be divided either within the skull or in the spinal canal.

2. **In a Mixed Nerve**, conveying motor as well as sensory stimuli, *nerve-stretching* has to be mainly relied upon. The trunk is laid bare, and traction exercised, both centrally and peripherally, by means of a blunt hook if the nerve is small, or of the finger placed under it if large. The clinical effect is to abolish the conductivity of the nerve for a time, either completely or partially; but since it is not divided, repair and restoration of function follow. The elasticity and extensibility of the nerves are considerable, and the pressure needed to cause their rupture has been accurately estimated. It varies much in different individuals, and allowance must be made for this in all operations. Thus, the sciatic nerve will stand about as much traction as an ordinary man can apply with his finger and thumb; it should be used steadily and continuously, not in a series of jerks. The effect of stretching is to free the nerve from external inflammatory adhesions, and to alter the relations between the sheath and its contents. Thus, the perineurium, instead of consisting of wavy fibrillæ, has the fibres straightened out, thereby compressing them, obliterating the lymphatic spaces between the fibres, and possibly rupturing the nervi nervorum. The nerve becomes hyperæmic, and the medullary sheath of the tubules may be irregularly broken up. The gray matter of the cord may also possibly be influenced, becoming hyperæmic if but slight traction is used, or showing hæmorrhages and exudation when much force is employed; but this has of course only been observed in animals; it is doubtful whether sufficient force could be exercised to produce such effects in man.

Affections of Special Nerves.

The Cranial Nerves.—The **Olfactory Nerve** may be involved in fractures extending across the cribriform plate of the ethmoid, or in severe cases of contusion of the anterior lobes of the brain without fracture. Loss of smell (anosmia) may be induced thereby.

The **Optic Nerve** is sometimes ruptured in fractures of the base of the skull involving the optic foramen, and sudden irremediable blindness results; or it may be compressed by hæmorrhage or inflammatory exudation, either within or outside of its sheath, leading to more or less complete loss of vision preceded by optic neuritis (*i.e.*, inflammation of the intraocular termination of the nerve, or papillitis); but if the hæmorrhage is not very severe, the amblyopia (or loss of vision) may be in measure recovered from. Orbital cellulitis not unfrequently causes pressure on the nerve, either as a result of the immediate inflammation or from the subsequent cicatricial contraction. Syphilitic disease of the sheath or the formation of a gumma in its neighbourhood, or intra-orbital aneurisms or tumours, may likewise induce amblyopia from pressure on the trunk.

The **Third Nerve** (*motor oculi*) being entirely motor, paralytic symptoms are those to be chiefly looked for. They may arise from *central* causes, such as syphilitic or degenerative changes in the floor of the third ventricle; or from *peripheral* lesions, such as aneurisms, tumours, trauma, etc., either in the orbit, sphenoidal fissure, or base of the brain.

The **Symptoms** of complete paralysis are as follows: (*a*) Ptosis, or drooping of the upper eyelid, from loss of power in the levator palpebræ superioris; (*b*) external strabismus, or squint, from paralysis of the inner, upper, or lower recti, the eye being also directed a little downwards from paralysis of the inferior oblique; (*c*) mydriasis, or dilatation of the pupil, from palsy of the iris; (*d*) loss of accommodation, from the ciliary muscle being paralyzed; and (*e*) some slight protrusion of the eyeball (exophthalmos), owing to most of its muscles being flaccid and relaxed. In consequence, however, of the close proximity of this nerve to the fourth, fifth, and sixth in the walls of the cavernous sinus and sphenoidal fissure, symptoms referable to these trunks are often associated with the above, as also venous congestion of the eye and orbit from pressure on the sinus. Should the eyeball be totally immobilized from paralysis of all its muscles without venous congestion, the condition is known as ophthalmoplegia externa, and is always due to central disease affecting the floor of the third ventricle, arising from sclerosis due to syphilis or tabes.

The **Treatment** in most cases consists in the administration of mercury and iodide of potassium.

Paralysis of the **Fourth Nerve** (*Pathetic*), which supplies the superior oblique muscle, results in defective movement of the eyeball downwards and outwards.

The **Fifth or Trigeminal Nerve** is occasionally torn or lacerated in head injuries, giving rise to anæsthesia, with perhaps ulceration of the cornea; but such cases are exceedingly rare. Much more common is the disease known as *trigeminal neuralgia* or tic douloureux, which is met with most usually in women, though not unfrequently in men. It is to be clearly distinguished from the simpler forms of neuralgia due to some local irritation or general weakness by the paroxysmal character and violence of the pain; hence the term 'epileptiform tic' has been applied to it, and not inaptly represents the terrible nature of the affection. As a rule, it commences in the infra-orbital or inferior dental branches, radiating thence to all the other divisions of the nerve. The paroxysms are not very frequent at first, but they rapidly increase both in number and severity, until at last the patient becomes utterly prostrate, and may be so depressed as to contemplate or even attempt suicide. The condition often depends a good deal on the general health, and intermissions of varying length occur. The attacks are accompanied by twitching of the muscles of the face, and even of the neck; also by unilateral sweating and hyperæmia of the head, and the development of such marked 'points douloureux,' that possibly the patients cannot brush their hair or wash their face on the affected side, which becomes dirty and often shiny from trophic changes or as the result of friction. Lachrymation is a marked feature during the attacks, and there may be a considerable increase in the salivary secretion, as also in that of nasal mucus.

As to the **Cause** of tic douloureux, but little can be said for certain, although many contributing conditions have been described, which may be classified under the following headings: (*a*) *Central* causes, such as changes of a sclerosing type in the deep centres of the fifth nerve, or in the Gasserian ganglion; (*b*) *radical*, or those due to compression or disease of the roots of the nerve, reaching from the ganglion to the cranial foramina; (*c*) *cranial* conditions, such as diminution in the size of the foramina of exit of the nerves, which vary immensely in different skulls, being generally smaller in women; they may be encroached upon by callus, inflammatory swellings, or tumours; (*d*) *peripheral* causes, *e.g.*, dental caries, narrowing of the walls of the bony canals, etc.; (*e*) *toxic* agents, *e.g.*, malaria, which especially tends to affect the supra-orbital nerve, constituting the so-called 'brow ague'; and (*f*) *reflex* phenomena, *e.g.*, ovarian disease, errors of refraction, etc.

In the **Treatment** of tic douloureux, innumerable remedies have been used, with a varying amount of success or failure, *e.g.*, quinine, where there is a malarial history; iodides and mercury for syphilis; iron and arsenic for anæmic patients; and, failing these, croton-chloral, paraldehyde, etc. All sources of reflex irritation should be removed or treated, such as carious teeth, errors of refraction, intra-nasal trouble, ovaritis, etc. If the pain persists, **Operative Measures** will, sooner or later, be called for. Neurotomy and nerve-stretching may give temporary relief, but most surgeons have been led by experience to the conclusion that the greatest measure of success follows neurectomy, and that the larger the portion excised, and the nearer that portion is to the central organs, the better the results attained. Hence much more extensive operations are now undertaken than formerly, even extending to the Gasserian ganglion itself.

We must now describe the different operations applicable to the chief branches of the nerve,* premising that all purely subcutaneous or submucous methods are to be condemned for their inaccuracy and inefficiency, as also on account of the bleeding which is likely to result from the closely contiguous bloodvessels.

The *Supra-orbital Nerve* does not very commonly call for division or extraction, since neuralgia of this trunk is often due to malaria, and is certainly more amenable to therapeutic measures than other forms. The pain usually recurs about the same time each day, and may be treated by giving a pill containing ferri sulph., 1 grain, quiniæ disulph., 2 grains, and morphinæ hydrochlor., $\frac{1}{8}$ grain, four hours before the attack is expected, and repeating it every hour till six pills in all have been taken. At the same time attention must be directed to any local cause of irritation. Should this fail to give relief, neurectomy should be undertaken. The nerve emerges from the orbit through the supra-orbital notch, lying at the junction of the inner and middle thirds of the upper margin, and is readily reached by an incision following the course of the eyebrow, through which the orbicularis can be divided along the line of its fibres (Fig. 92, *a*); the nerve is then easily exposed and dealt with. By incising the periosteum and depressing it, together with the orbital fat, by means of a spatula, the nerve can be followed back for some distance, and a considerable portion removed.

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* Owing to necessary limitations of space we must refer readers for further details to Rose on 'Trigeminal Neuralgia' (Baillière, Tindall and Cox, 1892).

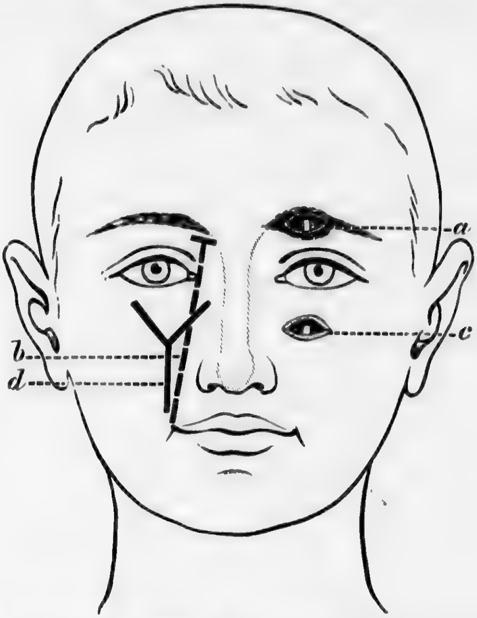

FIG. 92.—*a*, Incision for division of supra-orbital nerve; *b*, line indicating position of supra-trochlear nerve, passing from angle of mouth through the inner canthus; the short cross-line at its upper end is the incision required to expose it; *c*, position of infra-orbital nerve and incision; *d*, Carnochan's incision for neurectomy of the second division.

The *Supra-trochlear Nerve* has been stretched (somewhat empirically, it is true) for sundry obscure neuralgic affections of the eyeball, and occasionally with considerable success. It emerges from the orbit along a line drawn from the angle of the mouth through the inner canthus (Fig. 92, *b*). An incision is made at right angles to this course just below the eyebrow, and the nerve, which is found in several filaments, stretched or divided.

The *Infra-orbital Nerve* emerges from the foramen of the same name at a spot about ½ inch below the lower margin of the orbit, and at the junction of its middle and outer thirds. It may be reached by a horizontal or curved incision placed over this site (Fig. 92, *c*); but surgeons are now almost unanimous in the opinion that such an operation is unlikely to give more than temporary relief, and hence utilize one of the three following methods for reaching *the root of the second division*:

(*a*) The *orbital* operation, recommended by Langenbeck, Wagner, and Horsley, consists in tracing the nerve along the floor of the orbit, through an incision along its lower margin, and in breaking up the roof of the canal in which it lies. Care must be taken to strip up the periosteum in its entirety, so as not to open into the orbital fat, and to secure the infra-orbital vessels as far back as possible. We cannot recommend this method, since it does not deal with Meckel's ganglion, or the posterior dental branches; moreover, as the antrum is in most cases encroached upon, the wound is liable to become septic. Horsley recommends that if this cavity is by chance opened, it should be immediately filled with powdered boric acid.

(*b*) The *antral* method, devised by Carnochan of New York, and elaborated by Chavasse of Birmingham, lays bare the anterior wall of the antrum through a Y-shaped incision, the junction of the limbs being over the infra-orbital foramen (Fig. 92, *d*), and the three flaps thus marked out, including the periosteum, are raised from the bones. The antral cavity is now opened by a ½-inch trephine, and the posterior wall divided by a ¼-inch trephine, so as to expose the lowest part of the spheno-maxillary fossa, in which Meckel's ganglion is situated. The infra-orbital canal is now traced back to the same spot by chiselling through the upper wall of the antrum, and thus the nerve can be isolated, and its point of exit from the foramen rotundum made clear. It is divided by scissors as near to the skull as possible. Free hæmorrhage always results from this operation, but can be controlled by pressure with very hot sponges. The results are fairly satisfactory, although a disfiguring scar on the face remains; the space in which the surgeon has to work is very limited, and the opening of the antrum probably involves sepsis.

(*c*) The *pterygoid* method, or, as it is called, the Braun-Lossen operation, is without doubt the best for dealing with the root of the second division. The incision which we always employ commences at the external angular process of the frontal bone, follows the upper border of the zygoma, and curves downwards in front of the ear to reach the angle of the lower jaw (Fig. 80, F). The flap thus marked out, consisting only of skin and subcutaneous fat, is dissected forwards, temporarily fixed by a suture to the nose, and protected with gauze. The zygoma is exposed by a horizontal incision through the periosteum, which is cleared from the bone by a suitable raspatory, and drilled front and back so as to carry silver wires in the subsequent suturing up (Fig. 93); it is then sawn through and turned down together with the masseter. The mouth is slightly opened with a gag, and the temporal tendon pulled well backwards from the front of the temporal fossa by retractors, or if very large, is partially divided, exposing thereby the pterygo-maxillary fissure, with the internal maxillary artery entering, and the vein leaving it. These are secured by ligatures, and divided. The root of the second division of the fifth nerve can then be hooked up on an aneurism needle as it emerges from the foramen rotundum, and about ½ inch of it removed. This step is facilitated by chiselling away a bony prominence which rises from the base of the great wing of the sphenoid, on the posterior aspect of the junction of the two limbs of the pterygo-maxillary fissure. By also dividing the nerve as it emerges from the infra-orbital foramen through an incision in the face, the whole trunk is set free, and can be removed by traction, all the dental branches being torn across. The displaced structures are then put back in position, the zygoma is sutured with silver wire, and the incision in the skin closed. The results gained by this method (a modification of the original operation) have been very satisfactory, scarcely any scar persisting.

The *third division* of the trigeminal nerve has many branches, but the lingual and inferior dental are those mainly affected with neuralgia sufficiently severe to call for operative interference. They have been divided separately in the peripheral portions of their course, but with little success, and, as a rule, it is best to deal with them at the same time close to the foramen ovale.

The *Lingual Nerve* can be divided from within the mouth by a simple incision down to the bone, as it crosses the junction of the upper and middle thirds of a line drawn from the crown of the last lower molar tooth to the angle of the jaw; or it may be sought for more carefully after division of the mucous membrane. Such methods, however, lack precision, and are not only useless, but dangerous, owing to the necessary occurrence of sepsis.

The *Inferior Dental Nerve* has been approached in three ways; (*a*) From the mouth, according to the old plan. The mucous membrane is incised vertically over the entrance to the canal, which can be easily felt, and then, after defining the bony spine of Spix, which guards it, the nerve trunk is isolated and as much cut away as possible; (*b*) by trephining the inferior maxilla, and removing half its thickness, so as to expose the nerve in its canal, making the necessary incision along the lower border of the bone; and (*c*) by making an incision below the angle of the jaw, and working up behind the bone to the entrance of the dental canal, and there dividing the nerve (Lücke-Sonnenburg operation).

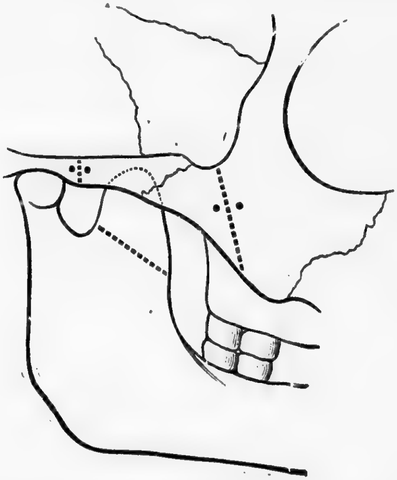

FIG. 93.—ZYGOMA AND LOWER JAW IN SITU TO SHOW POSITION OF SAW-CUTS AND DRILL-HOLES IN THE BRAUN-LOSSEN OPERATION, AND THAT FOR REMOVAL OF THE GASSERIAN GANGLION.

Section of the third division of the fifth nerve at the foramen ovale is best accomplished in the following manner: A flap of skin and subcutaneous tissue is reflected forwards from the parotid region, extending from the zygoma above to the angle of the jaw below (Fig. 80, F), exposing thus the parotid gland with the socia parotidis and the masseter muscle, covered by fascia. If the incision is kept strictly to the subcutaneous tissues, the facial nerve is in no way endangered. The masseter is then divided transversely immediately below the socia parotidis, and the vertical ramus of the inferior maxilla cleared of muscle and periosteum to a sufficient extent to allow the application of a ¾-inch trephine just below the sigmoid notch, the remaining bridge of bone being subsequently removed by cutting pliers; enough bone is left in front and behind to preserve the continuity of the jaw with the articular and coronoid processes. The fibres of the external pterygoid muscle can now be seen crossing the upper part of the wound horizontally, and over it the internal maxillary artery sometimes courses, giving rise to considerable hæmorrhage if it is wounded. The lingual and dental nerves are usually found close together, emerging from under the outer pterygoid muscle, and lying between the internal pterygoid and the bone. They should be divided below as far down as possible, whilst by drawing the external pterygoid outwards with retractors, the foramen ovale can be seen, if electric illumination is employed, and the nerve trunks divided at the point of exit. The wound usually heals well, and leaves but little scar, although some impairment in the mobility of the jaw may result, partly from the cicatrization following disturbance of the muscles and tissues, but mainly from paralytic atrophy of the muscles supplied by the divided nerve.

In cases where such measures have been adopted and have failed, or where the pain is referred to the whole nerve, *removal of the Gasserian ganglion* has been successfully attempted. The operations are so elaborate and recondite that we can only give a bare outline of them here.

Rose's operation approaches the ganglion through the pterygoid region, taking the 3rd division as its guide. An incision (Fig. 80, F) similar to that for exposing the foramen ovale is made through the skin, and the flap thus marked out is drawn forwards and stitched out of the way. The zygoma is drilled (Fig. 93), and turned down together with the masseter; the coronoid process is then divided or removed, and together with the temporal muscle turned upwards; the internal maxillary artery is, if possible, secured, and the sphenoidal attachment of the external pterygoid scraped away so as to allow of the exposure of the foramen ovale, which lies just in front of the base of the pterygoid processes. A ½-inch trephine is now applied immediately outside the foramen ovale, and the bone around the opening thus made is also removed by forceps or chisel so as to give more space. The trunk of the third division is traced upwards, the sheath of the ganglion opened, the second division cut through by means of a sharp cutting-hook, and the ganglion torn away piecemeal, or, at any rate, broken up. There is likely to be a good deal of bleeding, especially in the earlier stages of this operation, chiefly derived from veins; it can, however, be usually restrained by packing the wound for a few moments with sponges wrung out of very hot lotion. Efficient electric illumination is absolutely essential, since the wound is a very deep one.

The *Hartley-Krause operation* was devised independently by the two surgeons whose names are associated with it. An Ω-shaped flap is marked out in the temporal region, the base situated just above the zygoma. Through this the subjacent bone is divided by chisel or electric saw, and the whole flap of skin, muscle, and bone is turned down *en bloc*, exposing the dura mater, which is gently stripped up from the middle fossa of the skull as far as the cavernous sinus. Profuse hæmorrhage is likely to be caused by this proceeding, derived mainly from the middle meningeal trunk or its branches, and must be controlled partly by pressure, or possibly by plugging the foramen spinosum with purified sponge. The second and third divisions of the nerves are readily found beneath the periosteum, and are traced back to the ganglion as it lies on the apex of the petrous bone. A special cavity in the dura mater (or cavum Meckelii), in which the ganglion lies, has to be opened, whilst the first division courses along the walls of the cavernous sinus, to which it is most intimately adherent. Electric illumination is necessary in order to effect the removal of these structures, but apparently the whole ganglion, together with its branches, has been extirpated in this way.

As to ultimate results, it is even now a little difficult to speak authoritatively, since scarcely sufficient time has elapsed to draw final conclusions; but, as far as we can see, the freedom from pain is certainly more prolonged than after any of the operations upon the peripheral portions of the nerve trunks, and may possibly be permanent; certainly some of the cases on which we have operated have remained six or seven years without recurrence. The mortality of the two methods is much the same, and, according to latest statistics, based on about fifty cases of each, amounts to 10·5 per cent.

The **Sixth Nerve** may be torn or compressed, either in its intra-cranial course in the outer wall of the cavernous sinus, or as it passes through the sphenoidal fissure, or in the orbit, as a result of penetrating wounds or blows. Its paralysis causes internal strabismus.

The **Seventh, or Facial Nerve** may be *paralyzed* from a great variety of causes, which may be described under the following headings:

(*a*) *Intra-cranial lesions.*—If simply *cortical*, as from pressure, hæmorrhage, degeneration, etc., only a limited portion of the opposite side of the face is usually involved. If *sub-cortical*, or in the corona radiata, or corpus striatum, as from hæmorrhage, or softening, resulting either from carotid thrombosis or embolus, it appears on the opposite side, together with hemiplegia, and only the lower half of the face is palsied, the associated movements of the eyelids being left. If the lesion is situated in the *pons*, the facial centres may be implicated, and then facial paralysis, with rapid atrophy of the muscles, ensues on the same side as the lesion, together with loss of power of the opposite arm and leg (crossed paralysis). If the *root* of the nerve between the centres and the internal auditory meatus is involved, the whole of the same side of the face is paralyzed, accompanied, as a rule, by deafness.

(*b*) *Cranial Lesions.*—There are two not uncommon causes grouped under this heading, viz., (i.) fracture of the base of the skull, involving the petrous portion of the temporal bone, the paralysis supervening either immediately after the injury from laceration, a rare phenomenon, or some weeks later from implication in the callus, the usual cause; (ii.) as a complication of otorrhœa, due to sclerosis of the temporal bone, which leads to compression or inflammation of the nerve in the aqueductus Fallopii. In both these forms the palsy is complete on the side affected, and owing to the communication of the facial with the petrosal nerve in this part of its course there is unilateral drooping of the velum palati, the uvula being deflected towards the sound side.

(*c*) *Extra-cranial lesions* from injury, inflammation from exposure to cold, or the pressure of a tumour, *e.g.*, malignant disease of the parotid. This variety has been called 'Bell's palsy,' and is usually characterized by the whole side of the face being affected, but without implication of the palate or uvula.

The general **Signs** of facial paralysis are as follows: The side of the face is immobile and expressionless, all the natural folds and wrinkles being lost; the eye cannot be completely closed, and on attempting to do so the eyeball is usually seen to roll upwards and outwards; ulceration, and even perforation, of the cornea may result from this exposure. From the drooping and relaxation of the lower eyelid, the apposition of the punctum lachrymale to the conjunctiva is imperfect, and thus tears escape over the face (epiphora), a condition determined also by the loss of the suction-like action of the lachrymal sac, owing to the associated paralysis of the tendo oculi and tensor tarsi. On attempting to move the face, as in laughing or showing the teeth, it is drawn over to the opposite side. The lips cannot be closed firmly, and hence whistling and such-like actions are prevented. Moreover, food collects between the cheeks and the teeth, owing to paralysis of the buccinator, and the patient after a meal has to clear out the débris with a spoon or his fingers.

The **Treatment** of facial paralysis necessarily depends upon its cause. In the majority of cases medical treatment (including the administration of perchloride of mercury and iodide of potassium) will suffice, together with massage and electricity; in others, surgical measures with a view to remove some obvious cause of pressure will be necessary.

Facial Tic (or histrionic spasm) consists of a clonic contraction of the facial muscles, due either to some lesion of the centre in the pons, or to some irritation of the nerve trunk. The condition causes great discomfort to the patient, and may involve the whole side of the face, or merely one part of it, such as the orbicularis oculi. **Treatment** consists in *stretching*, or even in severe cases of division of the *facial nerve*, but is most unsatisfactory.

Operation.—The nerve is exposed in the upper part of the neck immediately below the ear, its position being indicated by a horizontal line drawn from the middle of the anterior border of the mastoid process, and usually corresponding with the point where the mastoid meets the lobule of the ear. The incision extends from a point just behind the external meatus along the anterior border of the sterno-mastoid muscle to the level of the angle of the jaw. The parotid gland is separated from the muscle, and both are well retracted, exposing by this means the posterior belly of the digastric. The facial nerve is found above this, running slightly downwards and forwards from the centre of the mastoid process. The great auricular nerve is partly divided in the superficial incision, and the posterior auricular vessels will require a ligature. The internal jugular vein is close to the posterior margin of the wound. The operation is by no means easy in a patient with a thick neck. The *effect* of the operation of stretching the nerve is to temporarily paralyze it, but the ultimate results have been by no means encouraging, only one case out of twenty collected by Godlee being successful.

The **Auditory Nerve** may be injured in fractures of the base of the skull, either one or both sides being involved. Incurable deafness usually results, often associated with facial palsy.

It is a little doubtful what effect would be produced by injury to the **Glosso-pharyngeal Nerve**, but in one case in which it was supposed to be compressed the patient suffered from difficulty in swallowing and speaking, together with persistent ulceration of the tongue; death resulted from œdema of the glottis.

A severe injury to the **Pneumogastric Nerve** is, as a rule, rapidly fatal, but symptoms of palpitation, vomiting, and a sense of suffocation following head injuries, may indicate that some less serious lesion has occurred. It is also exposed to injury in operations about the neck, *e.g.*, ligature of the carotid, or removal of tubercular glands. Irritation causes vomiting, and inhibition of the heart's action; one-sided division sometimes does comparatively little harm, but if both nerves are divided, death results from laryngeal paralysis, or from complications, such as œdema or congestion of the lungs. When the vagus is injured in the lower part of the neck or compressed by an aneurism, or if the recurrent laryngeal nerve is divided or compressed, hoarseness or partial aphonia is produced, from paralysis either of all the muscles on one side of the larynx, or in slighter cases only of the abductor (crico-arytenoideus posticus).

The **Spinal Accessory Nerve** may be irritated, either at its exit from the skull by a fracture running through the jugular foramen, or in its peripheral course by inflamed lymphatic glands, etc. Clonic spasm of the sterno-mastoid and trapezius is usually due to central changes, and it is for this form of spasmodic torticollis (p. 607) that *stretching or division of the spinal accessory nerve* is employed. The nerve runs downwards and backwards at right angles to the centre of a line passing from the angle of the jaw to the apex of the mastoid process. It is sought for as it enters the sterno-mastoid at a point about 2 inches below that spot, and on the deep side of the muscle. An incision is made along the anterior border of the sterno-mastoid, reaching from the ear to the cornu of the hyoid bone. The fascia is divided, and the muscle drawn backwards to expose the posterior belly of the digastric, from under the lower border of which the nerve emerges, passing first in front, and then below the transverse process of the atlas, which can be readily felt in the wound. The operation has not given very good results, since, although the twitching of the head and neck may cease, it is likely to recur elsewhere.

The **Hypoglossal Nerve** has been injured in a few cases, unilateral paralysis or weakness of the tongue being the result. Under such circumstances the tongue, when protruded, will be directed towards the paralyzed side.

The Spinal Nerves.

The nerves constituting the **Cervical Plexus** are exposed to injury either from blows, dislocations of the cervical spine, penetrating wounds, or during operations. As a rule, no very serious results follow, except in the case of the **Phrenic Nerve**, division of which may cause instant death by paralysis of the diaphragm, although when but one nerve is divided the patient may survive. Irritation of the nerve gives rise to spasmodic cough or hiccough.

The **Brachial Plexus** may be injured from exactly similar causes, paralysis, or spasm of the muscles of the arm, arising from division or irritation of the motor trunks, whilst hyperæsthesia or anæsthesia may follow from damage to the sensory trunks. Thus a blow on the back of the neck opposite the fifth or sixth vertebræ caused paralysis of the serratus magnus and rhomboids (winged scapula); an old unreduced unilateral dislocation of the seventh cervical vertebra produced intense neuralgia along the course of the ulnar nerve, and many similar instances might be mentioned. Less severe injuries, such as strains and contusions, frequently give rise to chronic neuritis of a somewhat severe type.

The **Treatment** must be dependent in large measure on the cause, if such can be ascertained; otherwise it is merely symptomatic, including the administration of iodide of potassium and the local application of blisters or other counter-irritants. In cases where there is severe and intractable neuralgia, not referred to any discoverable lesion, or where clonic spasm of the muscles of the arm and shoulder are met with, *stretching of the brachial plexus* may be called for.

Operation.—The patient lies on the back, with the head directed to the opposite side, and the arm well drawn down; a cushion is inserted under the shoulder to steady it. An incision is made above the centre of the clavicle, 3 or 4 inches in length, parallel to the anterior border of the trapezius. The platysma and deep fascia are divided, superficial veins dealt with as need be, and the deep cellular tissue opened up by retracting the margins of the wound. The posterior belly of the omo-hyoid is thus exposed, and the posterior border of the scalenus anticus defined. The cords of the plexus will be found emerging between the latter muscle and the medius; they are carefully isolated by division of the sheath covering them, and pulled upon by the finger or an aneurism needle passed under them. Special care must be taken of the lowest cord of the plexus, which passes behind the subclavian artery. The nerves should be stretched both centripetally and centrifugally. Excellent results have followed this operation, although in a few cases the necessary cicatrization which followed led to a recurrence of the symptoms.

The **Circumflex Nerve** is liable to injury from its exposed position, winding round the outer side of the neck of the humerus about a finger's breadth above the centre of the deltoid. Blows upon the shoulder may in this way cause paralysis; it may be torn or compressed in fractures of the surgical neck of the humerus, or in dislocation of the shoulder, or it may become impacted in the callus arising from the former injury. Paralysis of the deltoid and teres minor follows, evidenced by inability to raise the arm from the side, whilst the wasting of the former muscle causes undue prominence of the acromion. There may be temporary anæsthesia over the posterior fold of the axilla, but this does not last long. No operative treatment has been adopted, although we see no reason why it should not be attempted in suitable cases.

The **Musculo-Spiral Nerve** is not unfrequently damaged in fractures and dislocations of the upper extremity of the humerus, but is especially exposed to injury in the musculo-spiral groove, where it lies close to the bone. It is implicated with or without other nerves in crutch palsy (p. 373), or by lying in bed with the arm under the body.

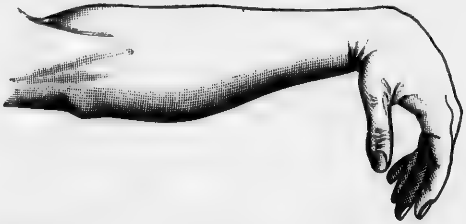

FIG. 94.—WRIST-DROP FROM PARALYSIS OF THE MUSCULO-SPIRAL NERVE. (TILLMANNS.)

The **Symptoms** arising from its total division are as follows:

A. Anæsthesia over the front and back of the outer side of the elbow and fore-arm (external cutaneous branches), over the radial side of the dorsal aspect of the wrist and hand, and over the back of the thumb, index, middle, and half of the ring fingers, extending to the base of the last phalanx (radial nerve, Fig. 95 B).

B. Paralysis of the following groups of muscles:
   (i.) Of the extensor of the forearm (triceps); hence the forearm is flexed.
   (ii.) Of the long and short supinators; hence the hand is pronated, the only supinator remaining being the biceps.
   (iii.) Of the radial and ulnar extensors of the wrist; hence wrist-drop (Fig. 94), a condition also present in certain lesions of toxic or central origin, *e.g.*, lead palsy, and progressive muscular atrophy.

(iv.) Of the extensors of the fingers and thumb, which either hang limp and motionless, or may be bent up into the palm from the unopposed action of the flexor muscles. If, however, the wrist and proximal phalanges are supported and extended, the terminal phalanges can be straightened by the action of the interossei and lumbricales.

Treatment consists in massage and electricity applied to the muscles, or in some cases an *operation* is necessary. The nerve is best exposed as it emerges from the musculo-spiral groove on the outside of the arm. The incision is made obliquely along the outer border of the biceps muscle, 'its centre corresponding to a point midway between the insertion of the deltoid and the external condyle' (Treves). The anterior border of the supinator longus is defined and drawn outwards, and the nerve with the termination of the superior profunda artery found between it and the brachialis anticus. From this point the nerve may be traced upwards, if necessary, by dividing the triceps. Where this has been preceded by considerable loss of substance of the nerve, so that the ends cannot be approximated, an inch or two may be excised from the shaft of the humerus with advantage, the bone being subsequently wired, and the nerve sutured. We have performed this operation with a successful result. To expose the upper part of the nerve as it enters the groove, the arm is placed over the body, and the lower border of the deltoid defined. An oblique incision is made a finger's breadth behind this, and the intersection between the long and outer heads of the triceps found. By opening up this space the finger can be passed down to the bone, and the nerve, together with the superior profunda artery, readily exposed.

Where the nerve is impacted in the callus arising from a fracture of the middle of the shaft of the humerus, it is often best to expose it by a median incision down the back of the arm, splitting the triceps.

The **Median Nerve** may be damaged in fractures and dislocations of the humerus, but is most frequently injured just above the wrist by glass wounds, due either to bursting of bottles, etc., or to thrusting the hand and arm through a window. *Paralysis* necessarily results in these cases with the following symptoms:

If divided just above the wrist:

A. Anæsthesia over the palmar aspect of the radial side of the hand, over the front of the thumb, index, middle, and half the ring fingers, and over the dorsum of the terminal phalanges of the same (Fig. 95, A, B).

B. (i.) Paralysis of the outer group of the short muscles of the thumb (*i.e.*, abductor, opponens, and outer half of the flexor brevis pollicis), so that the movement of 'opposition' is impaired, the thumb remaining extended by the side of the fingers (Duchenne's 'ape-hand').

This is always associated with marked wasting of the thenar eminence.

(ii.) Paralysis of the outer two lumbrical muscles, causing loss of power of flexion at the metacarpo-phalangeal joints of the index and middle fingers.

The great impairment of mobility in the hand and fingers so often seen in these cases depends not so much on paralysis of muscles as on the fact that in the majority of cases the synovial sheaths of the wrist are also laid open by the wound, and involved in septic inflammation, which leads to the formation of diffuse adhesions. Hence the prognosis is often unsatisfactory, even when the nerve has been skilfully treated by a secondary operation for nerve suture.

If divided at the bend of the elbow or in the arm, to the above-described symptoms are added:

(i.) Loss of pronation from paralysis of the two pronator muscles.

(ii.) Paralysis of the flexor carpi radialis, causing defective wrist flexion on the radial side, and impaired radial abduction.

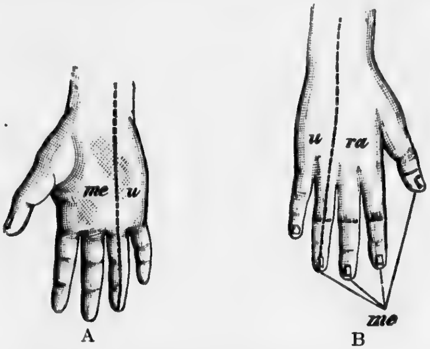

FIG. 95.—DISTRIBUTION OF SENSORY NERVES OF HAND FROM FRONT AND BACK. (TILLMANNS.)

me, Median nerve; *u*, ulnar; *ra*, radial.

(iii.) Paralysis of the flexor longus pollicis, of the flexor sublimis, and the outer half of the flexor profundus digitorum, leading to loss of power in the hand-grasp, especially on the radial side, and perhaps hyper-extension of the wrist.

(iv.) Paralysis of the palmaris longus.

Operations.—When the nerve has been divided, primary or secondary nerve suture should always be undertaken. In the latter case incisions are made through the old scars, which may be removed with advantage, the ends of the nerve clearly defined, and the bulb removed. Suture is often very difficult from lack of material, and to assist in the apposition of the segments the hand is flexed to a right angle, and also the elbow, and maintained in that position by a poroplastic or plaster of Paris splint.

In order to stretch the nerve, as in some cases of neuralgia, it may be exposed in the arm by an incision similar to that for ligature of the brachial artery, or at the wrist by an incision placed to the ulnar side of the flexor carpi radialis tendon, between that structure and the palmaris longus or flexor sublimis tendons.

The **Ulnar Nerve** is exposed to injury at the wrist, as also in the hollow between the olecranon and the inner condyle of the humerus, and paralysis may be caused by wounds, fractures, blows, implication in callus, etc. The symptoms are very characteristic.

If divided at the elbow :

A. Anæsthesia of the ulnar side of the front of the wrist and palm (palmar cutaneous branch), over the back of the hand, and of the little and half the ring fingers, back and front (Fig. 95, A, B).

B. (i.) Paralysis of the flexor carpi ulnaris, causing weakness in flexion and in ulnar adduction of the wrist.

(ii.) Paralysis of the inner half of the flexor profundus, with weakened hand-grasp, especially in the ring and little fingers.

(iii.) Paralysis of the two inner lumbricales and of all the interossei; hence, loss of adduction and abduction of the fingers, with flexion of the two last phalanges in each finger and hyper-extension at the metacarpo-phalangeal joint (main-en-griffe or claw-hand, Fig. 96). The interosseous spaces also become very evident from atrophy of these muscles.

(iv.) Paralysis of the short muscles of the little finger, of the inner group of short thumb muscles (adductor pollicis and inner half of flexor brevis), and of the palmaris brevis.

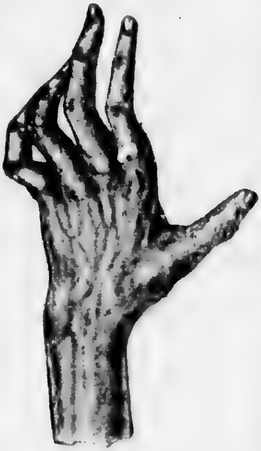

FIG. 96.—CLAW-HAND (MAIN-EN-GRIFFE) FROM ULNAR PARALYSIS. (AFTER BYROM BRAMWELL.)

If divided just above the wrist, the anæsthesia only involves the palmar aspect and back of the terminal phalanges, whilst the paralysis merely affects the short muscles of the hand. Additional impairment of movement may, however, arise from septic inflammation of the long tendons and their sheaths.

Treatment.—If divided, the nerve must be dealt with (according to the rules already given) at the injured spot.

To expose the nerve for the purpose of stretching for neuralgia, etc., the following methods may be adopted: (*a*) In the upper arm an incision is made similar to that for tying the brachial artery, but half an inch behind it. (*b*) At the elbow, cut down just behind the internal condyle, and find the nerve behind the internal inter-muscular septum with the inferior profunda artery. (*c*) Just above the wrist it lies to the radial side of the flexor carpi ulnaris between the tendon and the ulnar vessels; the skin and deep fascia alone need division.

Sciatica, or neuralgia of the great sciatic nerve, is a most painful affection, and often exceedingly intractable. It may arise from a great variety of **Causes**: (*a*) Inflammation of the neurilemma (acute or chronic), the result of cold, trauma, gout, rheumatism, syphilis, and many toxic agents; (*b*) pressure upon the extra-pelvic portion of the nerve, as by aneurisms, tumours, or old-standing dislocations of the head of the femur on the dorsum ilii; (*c*) similar pressure upon the nerve in the pelvis, or as it emerges through the sacro-sciatic notch, as from sarcoma or osteoma of the pelvic bones, rectal or uterine cancer, a pregnant uterus, or uterine fibroids; (*d*) pressure upon the nerve-roots in the spinal canal, as from caries or sarcoma; (*e*) chronic diseases of the spinal cord, such as tabes.

The **Symptoms** are very evident, the pain shooting down the back of the thigh and often referred to the toes. It is of a paroxysmal nature, and may be brought on by pressure over almost any part of the nerve or by movements of the thigh, and hence the patient's gait is stiff and shambling. Tenderness in the line of the nerve may be felt when the cause is a peripheral neuritis, and the trunk may sometimes be detected on palpation as a thickened cord. The limb is usually kept slightly flexed, but complete flexion of the thigh on the pelvis is an impossibility; and if, when the patient is standing against a wall, the limb can be bent to a right angle with the knee extended, it is certain that sciatica is not present.

The **Treatment** necessarily varies with the cause. If due to neuritis or perineuritis, general anti-syphilitic or anti-rheumatic remedies may be adopted, and blisters or sedative remedies in the more acute cases applied to the back of the thigh. Hypodermic injections of morphia and atropine may also be useful; but if all the usual anti-neuralgic remedies have been exhausted without benefit, stretching of the nerve may be employed.

Stretching of the sciatic nerve may be needed for: (i.) neuralgia of an intractable type; (ii.) paralysis or spasm of muscles supplied by it, owing to adhesions contracted between it and surrounding parts, the result of injury, cellulitis, or perineuritis; (iii.) in paralysis or spasm due to some forms of tabes. The nerve may also need to be exposed in order to suture it after it has been divided. Nerve-stretching may be accomplished without operation by flexing the thigh upon the abdomen and then extending the knee; in cases of sciatica an anæsthetic will be required for this, and it may be attempted before undertaking further measures. The nerve is best *exposed* for stretching at the point where it emerges from under cover of the gluteus maximus, midway between the tuber ischii and the great trochanter. The patient lies in the prone position with the limb slightly flexed, and a 4 or 5 inch incision is made vertically downwards from the fold of the nates in the middle line of the thigh. The lower border of the gluteus maximus is first exposed, and its fibres seen running downwards and outwards. The hamstring muscles emerging from under it are drawn inwards, and the nerve is found ensheathed in loose connective tissue; it is stretched, by a finger hooked under it, both peripherally and proximally.

The **Anterior Crural Nerve** may be paralyzed as a result of trauma or pressure, and may be the seat of neuralgia or spasm. Its division causes paralysis of the quadriceps extensor, pectineus, and sartorius, and the most marked effect will be secondary flexion of the knee-joint from the unopposed action of the hamstrings; anæsthesia extends over the front of the thigh and along the inner side of the leg and foot as far as the ball of the great toe. The nerve may be exposed on the outer side of the femoral vessels, just below Poupart's ligament, by a vertical incision half an inch outside the line of the artery.

The **External Popliteal Nerve** may be divided during tenotomy of the biceps tendon, to which it lies immediately internal; or compressed, as it winds round the neck of the fibula, by strapping, bandages, or the pressure of splints; or it may be injured in fractures of the neck of the fibula. Total division causes anæsthesia over the dorsum of the foot, together with paralysis of the extensor and peroneal groups of muscles; and from the contraction of the unbalanced opposing groups, the paralytic form of talipes equinovarus (p. 629) results. The nerve may be exposed by making an incision 1½ inches long to the inner side of the biceps tendon, terminating at the neck of the fibula. The knee is then flexed, and the nerve is readily found embedded in the loose cellular tissue of the popliteal space.

The **Internal Popliteal Nerve** is much less exposed to injury owing to its more sheltered position. Division results in anæsthesia of the back of the calf and sole of the foot, and in paralysis of the calf muscles, flexors of the foot and toes, and of the short muscles of the sole. Paralytic talipes calcaneo-valgus (p. 632) is very likely to ensue. The nerve is laid bare by a vertical incision in the centre of the popliteal space, which should avoid the short saphena vein. After division of the deep fascia, the nerve is the most superficial structure.

If the **Tibial Nerves** are divided, the resulting effects are more limited; thus, paralysis of the extensors of the foot and paralytic talipes equinus result from division of the anterior tibial; and paralysis of the short and long flexors of the foot and of the interossei, with resulting talipes calcaneo-valgus, follow lesions of the posterior tibial. The nerves may be exposed in the same way as the accompanying arteries (p. 288).

The **Sympathetic Nerve Trunk** in the neck is occasionally compressed by aneurisms or tumours. If merely irritated, dilatation of the pupil on the same side and unilateral sweating of the head and face are produced; but, if divided, the pupil is contracted from unbalanced action of the third nerve.

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CHAPTER XIII.

AFFECTIONS OF MUSCLES, TENDONS, AND BURSÆ.

Injuries of Muscles and Tendons.

Contusion.—Muscles may be bruised as a result of direct injury, such as blows or falls, leading to more or less extravasation, with possibly some rupture of the fibres. The part becomes tender and swollen, and any active contraction gives rise to pain for some time; passive movement, however, is tolerated, if the injured fibres are not thereby put on the stretch. Hot fomentations and rest may be needed for a few days; but friction, with stimulating embrocations and liniments, and regular massage of the parts, are subsequently necessary.

Sprains and Strains are due to violent efforts or falls, and result in the tearing or stretching of some of the muscular fibres. Considerable stiffness and rigidity may follow, especially in rheumatic and gouty patients. In such, rest and either hot or cold applications may be used at first; but friction with liniments and passive movements will be needed later. In individuals predisposed to the development of tubercular disease, special precautions must be taken to ensure complete recovery.

Rupture of the Sheath of a muscle is an accident occasionally met with, especially in the biceps cubitis or rectus femoris. The belly of the muscle, when contracted, protrudes through the opening as a hernia, constituting a soft semi-fluctuating swelling. In treating this condition the limb must be kept at rest in such a position as to relax the muscular fibres.

Displacement of Tendons rarely occurs, except in parts where these structures pass through osseo-fibrous canals, and particularly in those where the line of action is thereby changed. During some violent effort the patient feels a sudden localized pain, followed by a certain amount of limitation of mobility. This accident is popularly known as a 'rick.' In superficial parts the displaced tendon can sometimes be distinctly felt in an abnormal position, and this becomes more evident on attempting to move it. Thus the long tendon of the biceps may be dislocated from the bicipital groove;

various tendons about the wrist or ankle, especially that of the peroneus longus, may similarly suffer, as also the small muscles of the back. If left alone, the parts settle down more or less comfortably, but some permanent weakness may persist; whilst recurrence is very likely to ensue, especially if movement is permitted before the newly-formed connections have had time to consolidate.

Treatment consists in fully relaxing the muscles, and replacing the tendon, if possible, by manipulation. The parts are then immobilized and well supported, as by a plaster of Paris splint or strapping, and this should be maintained for six or eight weeks. If the displacement recurs, as is commonly the case where such treatment has not been adopted, it is sometimes advisable to cut down, expose the tendon, and stitch it back into position, using early passive movement to prevent the formation of troublesome adhesions. This is called for most frequently in the case of the peroneus longus tendon, which slips forward from its groove behind the external malleolus. The external annular ligament is thereby ruptured, and the operation called for consists either in suturing the divided segments, or in more aggravated cases it may be necessary to turn up a flap of periosteum from the malleolus and by stitching its apex to the outer side of the os calcis secure the tendon in place.

Rupture of Muscles and Tendons is by no means an uncommon accident, resulting from any excessive violence of a sudden and unexpected nature. Most frequently the tendon gives way at its union with the muscular belly; less often the belly itself yields, whilst occasionally the tendon may snap, or the point of bone to which it is attached may be torn off.

Signs.—The patient at the moment of the accident experiences a sharp and severe pain, as if he had been struck with a whip; he may also feel or hear a snap. Loss of function follows, together with a certain amount of swelling and bruising, which is more evident if the muscular fibres have been torn across than if the tendon has alone been lacerated. On attempting to contract the affected muscle, the belly rises up as a soft, rounded, semi-fluctuating tumour, drawn towards the uninjured attachment, if the union between the tendon and belly has given way; whilst if the lesion has been through the muscular substance, the divided halves of the belly become similarly prominent, and a distinct gap or sulcus can be felt between them.

Repair is established in the usual way already described (p. 191), viz., a cellulo-plastic effusion is first poured out, taking the place of the blood-clot which is absorbed; this becomes vascularized into granulation tissue, and finally cicatricial tissue is developed. Where a muscular belly is involved, a long and weak bond of union is likely to form, if the ends have been much separated; but when they are closely apposed, the cicatrix may be a short one, and then tends sooner or later to be replaced by true muscular tissue. When a tendon has been divided or torn, the connecting medium is at first attached to the sheath, and if this adhesion persists, it may lead to much pain and weakness. It is an exceedingly interesting fact to note how rapidly this tissue attains a considerable degree of strength; a rabbit's tendon ten days after division requires a weight of 56 lb. to break it (Paget).

Treatment.—It is essential to relax the parts fully so as to prevent separation of the divided ends, and to maintain them in this position for a lengthened period, *e.g.*, four or six weeks. Any stiffness resulting may be combated by passive movements and massage, whilst, if need be, adhesions may be broken down under an anæsthetic. Tendons accidentally divided in open wounds should be sutured together by catgut, special antiseptic precautions being adopted to prevent spreading suppuration along the tendon sheaths. Where there has been actual loss of substance in a tendon, it is possible to remedy the defect by grafting a portion of tendon from another patient, or from an animal, between the two ends; or, again, one end may be split longitudinally in such a way as to leave it attached peripherally, so that the free end (*a*) can be turned down and united to the other segment (Fig. 97). When muscular bellies have been divided, it is not difficult to secure them, if the fibres have been severed longitudinally or obliquely; but when the section is transverse, there is a great tendency for the stitches to cut out. In such a case it is advisable to encircle with a ligature a bundle of muscular fibres on either side of the incision, and then tie the two threads together. This may be done at several spots in the cross-section, and the muscular ends can thus be safely approximated.

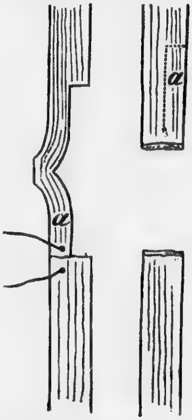


FIG. 97.—METHOD OF UNITING TENDON AFTER LOSS OF TISSUE BY TURNING DOWN A PORTION OF IT AS A FLAP.

The *long tendon of the biceps* is not unfrequently torn from the muscular belly, which, on attempting to bend the arm, is drawn down towards the elbow, constituting a soft tumour, somewhat resembling a lipoma. No special treatment is needed beyond keeping the forearm flexed for a time. If the *tendo Achillis* is ruptured, union may be attained by keeping the knee bent and the heel raised, as by securing a strap to the back of a slipper below, and to a dog-collar passed round the knee above. Possibly a better result would follow an antiseptic incision and suture. Similarly, if the *ligamentum patellæ* gives way, suture through an open wound is more satisfactory than mere elevation of the leg and rest; but no such open methods must be adopted unless the surgeon is quite confident in his ability to maintain absolute asepsis. The *inner head of the gastrocnemius* is sometimes torn in wrenches or slips, as at lawn tennis; and it is possible that the *plantaris* may be similarly affected. The *adductor longus* may be lacerated in violent attempts to maintain a seat on horseback, and constitutes one form of riders' sprain; it is treated by rest and the application of a firm spica bandage.

Diseases of Muscles.

Inflammation of Muscles (Myositis) may arise from a variety of circumstances, but the chief results are alike, whatever the cause, viz., a more or less painful infiltration of the muscle, with increased discomfort on attempting movement. The part feels hard and rigid, and may be tender to the touch. If suppuration ensues, the ordinary signs of an abscess subsequently make themselves evident. A certain amount of contractile tissue is thereby destroyed, and the cicatricial changes induced will possibly lead to deformity.

Varieties.—(1) **Simple Traumatic Myositis** results from contusion or laceration of the fibres, and is merely a plastic inflammation, with or without hæmorrhage, running on to resolution, with perhaps a little fibroid thickening of the part. It is liable in some cases to become chronic, and may lead to considerable changes in the structure of the muscle (*M. fibrosa*), whereby it becomes shortened and replaced by fibrous tissue. The induration of the sterno-mastoid muscle met with in children is probably of this type. In still other cases ossification of a limited portion of the muscle or tendon may occur from long-continued and frequently-repeated irritation; thus, in riders the upper portion of the adductor tendons may in this way become bony, constituting the so-called 'riders' bone.'

2. **Rheumatic Myositis** usually results from exposure to cold, *e.g.*, wry neck from sitting in a draught. It is of a plastic type, and may produce some subsequent induration. It is treated by hot fomentations, and ordinary saline anti-rheumatic remedies, whilst later on friction with stimulating embrocations is needed.

3. **Acute Suppurative Myositis** is the effect of infection with pyogenic organisms, either from without, as after operation wounds, punctures, gun-shot injuries, gangrene, etc., the pus in such cases spreading widely up and down the muscular planes; or from within the body, as in pyæmia, or by extension from neighbouring suppurative foci, such as from sub-periosteal abscesses; it may also arise after a contusion or sprain by auto-infection. Great cicatricial deformity may result in such cases.

4. **Chronic Tubercular Myositis**, with the formation of a chronic abscess, is not an uncommon secondary consequence of a similar affection of neighbouring bones or joints—*e.g.*, a psoas abscess.

5. **Syphilitic Disease** is usually met with in the tertiary period, and takes the form either of a diffuse sclerosis or of a localized gumma. Any muscle may be affected, but perhaps the tongue and sterno-mastoid are those most frequently involved. Considerable care is needed in making an exact diagnosis, since these conditions closely resemble tumours in their method of onset; but the presence of a syphilitic history, the slow growth, the hardness with subsequent central softening, and the rapid disappearance after the administration of iodide of potassium, should suffice to determine their nature.

6. **Parasitic Myositis**, arising from the presence and irritation of either the *Trichina spiralis* or of hydatids, need not be described here.

7. **Myositis Ossificans** is a very rare disease, of which but little is known beyond the facts that various muscles, especially those of the back, are transformed into bony plates or rods, which may lead to extensive ankylosis. The process seems to be one of ossification of the connective tissue associated with atrophy of the muscular fibres, and is always extremely painful. It is most commonly seen in young males, and is possibly rheumatic in origin. No treatment has proved of any value.

Tumours of Muscles are not very common. Primary growths consist of angioma, fibroma, chondroma, myxoma, or sarcoma, and of these the majority start in the fibrous sheaths or the inter-fibrillar connective tissue. Secondary deposits of both carcinoma and sarcoma occur, but there is nothing special to be noted about them.

Treatment must be determined on ordinary surgical principles. If sarcomatous, the whole thickness of the muscle should, if possible, be excised for some distance from the growth, the sheath forming a natural limit not early overstepped. Amputation of the limb, may, however, be called for at a later date.

Diseases of Sheaths of Tendons.

The synovial membranes which line the sheaths of tendons are liable to various forms of inflammation, usually resulting from injury:

1. **Acute Simple Teno-Synovitis** often follows sprains and strains, and is most commonly seen in connection with the extensor muscles of the thumb. A puffy swelling in the course of the tendons is produced, painful on movement and perhaps tender to the touch, giving a characteristic fine crepitus whenever the parts are moved. All that is needed for its **Treatment** is to immobilize

the limb for a few days, and apply hot fomentations. As soon as the more acute symptoms have disappeared, friction, with stimulating embrocations, and pressure are employed to assist the absorption of the fluid; whilst active and passive movements are encouraged to prevent the formation of adhesions.

2. **Acute Suppurative Teno-Synovitis** may result from a punctured and septic wound of the synovial sheath, or the inflammation may spread to it from neighbouring tissues. The thecal variety of whitlow (p. 190) is an example of this affection. Suppuration may extend both up and down the sheath, and gives rise to both local and constitutional symptoms. Unless promptly treated by early incision and evacuation of the pus, the tendons will very probably slough, or may contract extensive adhesions to neighbouring parts; in either case considerable impairment of function follows. It is also possible for suppuration to extend to neighbouring articulations, leading to their disorganization; thus, the wrist-joint may be involved in suppuration of the extensor tendon sheaths.

3. **Chronic Simple Teno-Synovitis** is a common affection, and is characterized by a passive effusion of glairy synovia, somewhat resembling the white of egg, into the tendon sheath. It may be limited in extent, constituting one of the varieties of ganglion, or diffuse. An elastic fluctuating swelling forms in the course of a tendon, usually associated with crepitus. There is no pain or tenderness, but the affected part feels weak. **Treatment** consists in counter-irritation and pressure, as by Scott's dressing; failing this, the part may be freely incised, the synovia removed, and, if need be, the cavity washed out. In the more localized forms it may suffice to puncture the cyst-like swelling and squeeze out the contents, pressure being subsequently applied. Of course, the most rigid asepsis is an essential in such treatment.

4. **Chronic Tubercular Teno-Synovitis** is of two distinct types. In one a pulpy degeneration of the synovial membrane occurs, similar to that met with in tubercular arthritis (p. 569). The sheath is lined by œdematous granulation tissue of some thickness containing tubercular foci, giving rise to an elastic pulpy swelling along the course of a tendon, which increases slowly in size, and is but slightly painful or tender. Chronic suppuration is very likely to result, and subjacent bones and joints are liable to be involved. **Treatment** consists in immobilizing the part, pressure, and improvement of the general health. If a cure is not quickly established, a free incision should be made and the diseased tissue removed.

The other form of tubercular disease consists in a passive effusion into the synovial space, the lining membrane of which becomes thickened by the deposit thereon of fibrinous material. At the same time there is usually a large development of the so-called 'melon-seed bodies,' which are in reality laminated masses of fibrin, perhaps containing traces of tubercular giant-cell systems. When numerous they give rise to a curious and characteristic form of crepitus. That they are of a tubercular nature can be demonstrated by inoculation experiments; the spores or bacilli contained therein are not, however, in a very active state.

Treatment consists in laying the part open and removing the effused fibrin and melon-seed bodies, together with as much of the thickened membrane as possible.

A **Ganglion** is the term given to a localized cyst-like swelling forming in connection with tendon sheaths. It is most commonly met with at the back of the wrist, arising from the tendons of the thumb or index-finger, but it sometimes occurs on the front of the wrist or in the foot. It varies in size considerably, and contains a clear transparent gelatinous or colloidal substance. A rounded firm elastic swelling is produced, somewhat moveable as a rule, and neither painful nor tender at first, although some painful weakness of the part may be caused as it increases in size. As to its *origin*, many opinions have been expressed, but probably it may be due to one of several causes: thus, it may result from a chronic localized teno-synovitis, or a hernial protrusion of the synovial membrane through an opening in the tendon sheath. Others seem to originate in a colloidal degeneration of the cells lining the synovial space; whilst certainly some few arise in connection with subjacent articulations, in the same way as a Baker's cyst (p. 563).

Treatment.—When small, a ganglion may often be ruptured by manipulation and pressure with the thumbs, or by a forcible blow with a book. Firm compression by strapping over it a coin or small portion of wood enclosed in lint has been recommended, but is of little value. A rapid cure is usually obtained by an aseptic puncture of the cavity, and the subsequent application of firm pressure. In some cases it may be advisable to lay the part freely open and remove the cyst wall; if such treatment is performed aseptically no harm will result, but, if sepsis is admitted, most serious consequences may ensue, even leading to disorganization of a neighbouring joint.

A **Compound Palmar Ganglion** consists in a tubercular affection of the common synovial membrane surrounding the flexor tendons of the wrist, the cavity being distended with synovia, usually containing many melon-seed bodies. It forms a large swelling extending above and below the wrist, fluctuation being readily transmitted from one part to the other beneath the annular ligament; it also extends amongst the muscles of the thenar eminence along the tendon of the flexor longus pollicis. In the **treatment** an incision should be made both above and below the annular ligament, the cavity being well washed out, and all melon-seed bodies and fibrinous débris removed with a sharp spoon; a drainage-tube is subsequently inserted. In a few severe cases it may be necessary to divide the annular ligament in order to efficiently deal with the trouble.

Tenotomy.

By tenotomy is meant the division of a tendon through an open or subcutaneous wound with the object either of remedying some deformity, such as talipes or torticollis, or of assisting the surgeon to reduce some displacement, as in the setting of a fracture; thus, the tendo Achillis may require division in fractures of the lower leg in order to overcome the muscular contraction.

There are two chief methods by which division of tendons is accomplished, viz., the subcutaneous and the open. The **subcutaneous** method is made use of where there are no important structures in the neighbourhood liable to injury. The object is not to exclude the air, the admission of which, it is well known, does no harm to an aseptic wound, but simply to divide a non-vascular structure through a small puncture, which is healed in a few days. It is stated in certain accredited text-books that antiseptic precautions are unnecessary in such a proceeding; we desire here most emphatically to maintain that the strictest attention to asepsis is desirable, since the character of the wound, viz., a puncture, and the entire absence of drainage, are most favourable to the development of septic organisms, if entrance is once given to them. Moreover, the synovial tendon sheath is often, though undesignedly, wounded, and any septic inflammation would rapidly spread along this structure, and give rise to the most serious consequences. The operation, as usually performed, consists in inserting a sharp-pointed tenotome through the skin down to the tendon. This is then withdrawn, and a blunt knife passed along the wound thus made, either superficial to or beneath the tendon. The cutting edge is turned towards it, and the tendon divided by a sawing movement, whilst the structure is put on the stretch by an assistant. Various opinions are entertained as to whether it is better to pass the knife above or below the tendon; the advantages of the former method are that there is no likelihood of making an unduly large wound in the skin, and that there is less risk of dividing the *lax* subjacent structures if the knife is turned towards them. On the other hand, if the knife is at once passed below the tendon, and any such subjacent structures are by mistake included, their division is a matter of certainty. On the whole, then, if a subcutaneous operation is considered advisable, one prefers to cut towards the dangerous area rather than away from it. In those cases, however, in which there is any risk of dividing important structures, such as the external popliteal nerve in tenotomy of the biceps cruris, it is wiser to adopt the **open method.** In this an incision about 1 inch in length is made over the tense tendon, which can thereby be exposed, lifted on an aneurism needle, and severed without danger. There is no hæmorrhage worth mentioning, and the wound is closed with a point or two of suture. As to *after-treatment*, all that is needed is to place a pad of antiseptic gauze over the puncture, and to secure it by collodion. The practice of surgeons at present varies a good deal with that which was formerly adopted in the reduction of the deformity. Formerly the part was put up with the deformity still persisting in an adjustable apparatus, by means of which it was gradually brought into the desired position. Now it is a common practice to at once remedy the malposition by immobilizing the part in plaster of Paris. Equally good results are thereby attained in a shorter space of time, and without any need for expensive or complicated apparatus. The fears formerly entertained about the immediate separation of the divided ends of the tendon have been shown to be groundless.

As to the **method of repair**, as soon as a tendon is divided, the ends retract to a greater or less degree, leaving an interval, which is at first filled with blood clot. This is transformed, according to the method described elsewhere, firstly into vascular granulation tissue, and finally into a fibrous cicatrix. The tendon thus becomes actually lengthened. This new tissue is at first adherent to the sheath, but later on may regain free mobility within it.

Tenotomy of the Tendo Achillis.—The foot is placed on its outer side, and the tendon relaxed by pointing the toes downwards. The tenotome is introduced about 1 inch above its insertion at the inner margin of the tendon, either superficial to or beneath it, and it is readily divided when the foot is extended. If the surgeon cuts towards the skin, he must be careful not to divide the last few fibres too rapidly, otherwise a considerable external wound may be inflicted by the suddenly liberated knife.

The *Tibialis Anticus* is usually divided about 1 inch above its insertion, as it crosses the scaphoid bone. There is here no synovial sheath, and the arteria dorsalis pedis is separated from it by the tendon of the extensor proprius hallucis. It is first relaxed so as to allow of the introduction from the outer side of the sharp tenotome beneath it; this is then replaced by a blunt-pointed instrument, and the section is readily accomplished when the foot is again made tense and abducted.

The *Tibialis Posticus* is usually divided together with the flexor longus digitorum just above the base of the inner malleolus, at a spot about a finger's breadth from the tip of that process in an infant, and about $1\frac{1}{2}$ inches from it in an adult. A small tubercle can usually be felt at this spot, and the section must be made just above it. The knife is inserted vertically between the tibia and the tendon, and is kept as near the bone as possible. If correctly placed, it remains fixed without the support of the hand, being grasped between the tendon and the bone. The blunt tenotome is then introduced, and the edge, being turned towards the tendon, the latter structure is divided when the foot is extended. The posterior tibial vessels may be wounded if the tendons are too suddenly severed, but even should this occur, a little well-adjusted pressure will suffice to prevent any serious consequences.

The *Peronei* tendons are divided just above the base of the outer malleolus, at a spot where the synovial sheath is usually absent The tenotome is inserted close to the fibula, between the tendons and the bone.

The *Biceps Cruris* tendon is best divided by an open operation, on account of the close propinquity of the external popliteal nerve, which has been divided more than once, when the subcutaneous operation has been adopted. An incision is made in the direction of the tendon just above its insertion into the fibula. It is readily lifted upon an aneurism needle and divided; muscular fibres will probably be found to extend quite close to its lower end.

The *Semi-membranosus* and the *Semi-tendinosus* tendons are dealt with just above the line of the knee-joint, and the subcutaneous operation may be conveniently adopted where they are prominent and tense.

For division of the *Sterno-mastoid*, see p. 608.

Diseases of Bursæ.

Bursæ exist as normal structures in many parts of the body exposed to pressure, their object being to diminish friction and permit of a gliding movement. Similar cavities, known as abnormal or **Adventitious Bursæ**, are developed in regions where exceptional pressure is brought to bear on some prominent part of the body; they consist of a fibrous wall lined by serous membrane, contain serum, and are formed either by dilatation of lymphatic spaces, or as a result of a localized effusion into the tissues. Examples of this are met with in men following particular occupations; *e.g.*, Covent Garden porters from carrying baskets on their heads, a pad of sacking reaching down to their necks alone intervening, develop a bursa over the vertebra prominens, known as a 'hummy'; Billingsgate fish-carriers occasionally have bursæ under the centre of the scalp; and deal-runners often present one on the upper part of the shoulder. They occur over the bony prominences arising from malformation or displacement, *e.g.*, in talipes equino-varus, over the cuboid; in bad cases of genu valgum, over the internal condyles of the femur; whilst the false joint or pseudarthrosis which occurs in unreduced dislocations or ununited fractures is also of this nature.

The following are the morbid conditions which arise in adventitious as well as normal bursæ:

1. **Acute Simple Bursitis**, which may result from a non-penetrating injury, or from prolonged irritation, especially in gouty or rheumatic individuals. The part becomes swollen, painful, and tender,

and if superficial the skin over it may be hyperæmic. Effusion into the cavity quickly occurs, the fluid being spontaneously coagulable in the early stages, and if resulting from traumatism mixed with blood. Lymph is deposited on the serous surface, and in many cases results in the formation of adhesions, and possibly obliteration of the cavity. **Treatment** consists in keeping the part at rest, and applying hot fomentations, whilst suitable constitutional remedies are also administered. If the effusion tends to persist, aspiration, or removal with trocar and cannula under strict asepsis, may be employed, or even the whole cavity excised.

2. **Acute Suppurative Bursitis** arises from infection occurring either from without or within. In this condition all the phenomena, local and constitutional, usually associated with the formation of a superficial or deep abscess are present. The pus, formed at first within the bursa, tends after a time to come directly to the surface, or bursting through the capsule to be diffused through the tissues. Where this occurs, the characteristic features suggesting a bursal origin of the abscess may be masked. Thus, in suppuration of the bursa patella, the pus may find its way to the lateral aspects of the limb, allowing the patella to be distinctly felt through the skin; the case is then very apt to be mistaken for suppuration of the knee-joint, from which, however, it is easily recognised by the absence of the more acute arthritic symptoms. Extension to subjacent bones and joints may, however, occur; thus, the patella or olecranon may become carious, or necrose. The **Treatment** of suppurative bursitis resolves itself into an early free incision, and drainage.

3. **Chronic Bursitis with Effusion** is, perhaps, the most common pathological condition met with in connection with bursæ. The cavity becomes distended with a serous effusion of varying amount, giving rise to a fluctuating tumour. The walls differ in thickness according to circumstances; if the condition is one of long standing, or if frequent recurrences have been present, the bursal wall is usually reticulated and dense, and adhesions or fibrous cords are often produced. Subacute exacerbations are frequently grafted on the more chronic variety. The **Treatment** consists in rest and counter-irritation, as by blistering or iodine paint, and if this fails, removal of the fluid and pressure. If the condition recurs, the bursa should be dissected out. Special care will have to be taken in dealing thus with bursæ communicating with joints, such as that under the semi-membranosus tendon; the lumen of the tumour should not, if possible, be opened, but its neck must be isolated, and its communication with the joint shut off by applying a catgut or silk ligature.

4. **Chronic Fibroid Bursitis.**—In this form the walls of the bursa become chronically thickened, as a result of the prolonged irritation, and also possibly from the effect of syphilis. There

is but little effusion; consequently a hard fibroid tumour is met with in the region of the bursa, and in the centre of this is a small cavity. The only **Treatment** is complete removal.

5. **Chronic Tubercular Bursitis** may occur either in the form of a fibrinous deposit on the inner wall, together with effusion and the presence of melon-seed bodies, or the lining membrane may undergo a change analogous with that described as pulpy degeneration of a joint, leading to the formation of a chronic abscess. Either condition may be secondary to a tubercular arthritis, or may give rise to it, when the bursa communicates with a joint. If total removal is impracticable, the **Treatment** consists in laying the part freely open, scraping away all tubercular tissue, and stuffing the cavity with gauze impregnated with iodoform.

6. **Syphilitic Changes** may also occur in bursæ, in the shape either of a symmetrical bursitis in the early stages, or later on as a gummatous peri-synovial development; they require no special notice here.

Occasionally **Gouty Deposits** are observed in the walls of bursæ, constituting tophi, the irritation of which may predispose to abscess formation, pus mixed with urate of soda crystals being discharged. The bursa over the olecranon is said to be most frequently affected in this way.

Special Bursæ.

The *bursa patellæ*, which lies over the lower margin of the bone and not over its centre, is exceedingly liable to injury and inflammation from its exposed situation, and especially in those who are called upon to kneel much, giving rise to the condition known as 'housemaid's knee.' Any of the above varieties of bursitis may be met with, and their signs are so evident that it is unnecessary to again mention them in detail. The relation of the bursa to the patella explains the fact that suppuration sometimes gives rise to caries or superficial necrosis of that bone, whilst the chronic and subacute inflammations may lead to thickening of the bone from osteo-plastic periostitis.

The bursa beneath the ligamentum patellæ, between it and the head of the tibia, when distended with fluid gives rise to a fluctuating swelling felt on either side of the tendon, more especially when the limb is extended; when the leg is flexed the swelling disappears. Chronic enlargement of this bursa may cause the ligamenta alaria to be pushed backwards into the joint so that they are nipped between the bones whenever the patient attempts to stand with the leg extended; the pain thereby induced is somewhat similar to that caused by a displaced semilunar cartilage, or by a loose foreign body in the joint. The inability to stand with a straight leg, and the presence of the enlarged bursa, are sufficient, however, to guide the surgeon to a correct diagnosis.

The bursæ in the popliteal space are often enlarged, especially that beneath the inner head of the gastrocnemius, leading to a rounded fluctuating swelling, sharply limited on its outer aspect, and more fixed and less defined towards the inner side. The sensation imparted to the fingers varies according to the position of the limb, the swelling being *tense in extension and flaccid in flexion*, as occurs in most of these peri-articular bursæ. Owing to the proximity of the popliteal vessels, pulsation is occasionally detected; but it is only heaving, not expansile in character. The fact that the bursa usually communicates with the joint necessitates considerable care in its treatment. Aseptic tapping, followed by pressure, may suffice; but if this fails, the cavity should be entirely removed by a careful dissection, the communication with the joint being closed by ligature or suture.

The *bursa beneath the insertion of the semi-tendinosus and gracilis* is sometimes inflamed, and is very liable to lead to osteo-plastic periostitis of the subjacent inner surface of the tibia.

The *bursa beneath the tendo Achillis*, if enlarged, presents a fluctuating swelling on either side of that structure, somewhat simulating disease of the ankle-joint, but necessarily limited to the posterior aspect of the joint.

Distension of the *bursa beneath the psoas tendon* gives rise to a fluid swelling which usually projects anteriorly, presenting on the inner side of Scarpa's triangle. If painful, it necessitates flexion of the thigh, and thus leads to symptoms resembling in measure those of hip-joint disease. It must not be forgotten that this bursa often communicates with the joint.

The *bursa over the tuber ischii*, if inflamed, gives rise to the condition known as 'weavers' bottom'; it causes great discomfort in sitting, and is often solid and symmetrical. If troublesome, it should be removed.

Enlargement of the *bursa over the olecranon* constitutes the condition known as 'miners' or students' elbow'; suppuration within it is not uncommon, leading to necrosis of the underlying bone; the elbow-joint is but rarely affected. It is sometimes laid open as a result of a fall on the flexed elbow, the overlying skin splitting; such must be treated by enlarging the opening, if need be, and stuffing the cavity.

The large multilocular *subdeltoid bursa* is occasionally enlarged; it leads to prominence of the deltoid, and expansion of the shoulder. (For diagnosis from effusion into the shoulder-joint see p. 557.) Where treatment by counter-irritation and rest fails, the cavity should be incised and drained.

CHAPTER XIV.

INJURIES OF BONES.

Contusion of a Bone and of its underlying periosteum is, as a rule, a matter of no great moment, although the part becomes painful, swollen, and bruised. Occasionally a subacute periostitis may be caused, especially in people liable to rheumatism or gout, or in the subjects of syphilis; whilst in people who are thoroughly out of health, and with low germicidal power, acute infective periostitis or osteo-myelitis, resulting in necrosis, may be lighted up. The **Treatment** of an uncomplicated case consists merely in the application of a bandage and cooling lotion, whilst if periosteal thickening result, iodide of potassium may be needed, and iodine paint locally.

Bending of Bone may or may not be associated with fracture. Bending without fracture occurs mainly in children, and in adults is only the result of some local disease. More commonly a partial fracture is present, constituting the condition known as green-stick fracture (p. 359). The deformity can generally be remedied by the application of a little force.

Fractures.

A fracture may be defined as a sudden solution of continuity in a bone, resulting usually from external violence.

Predisposing Causes of Fracture.—*Age* has a considerable influence in the determination of fractures, and for two reasons: firstly, because the strength and elasticity of bones vary considerably at different periods of life; and, secondly, because the liability to injury is likewise variable. From two to four, fractures are not uncommon, owing to the unsteady gait and frequent falls to which little children are exposed; from four to six they are less common, the bones often bending so as to cause green-stick fractures, whilst injuries near joints induce separation of epiphyses; from six years onwards fractures are common enough, and increase steadily with the age, old people being peculiarly liable to this form of accident, owing to the brittleness of their bones.

Sex.—As might be expected, fractures are more common in the male sex during boyhood and adult life; but up to the age of four or five they are equally frequent in the two sexes, whilst after forty-five they are more common in women, owing to their great liability to intracapsular fracture of the cervix femoris and to Colles's fracture.

Morbid Conditions of the Bones, moreover, predispose to fracture in a marked manner, very slight force occasionally sufficing to bring it about. Under this heading may be included: (1) Atrophy of bone, from whatever cause it arises. Thus, it may be of the senile type, as manifested especially in the cervix femoris and lower jaw; or it may be caused by want of use, as in a paralyzed limb or from an ankylosed joint. Certain nervous affections, such as general paralysis and other forms of insanity, and even tabes dorsalis, are often associated with atrophic conditions of the bones, which lead to fracture without any apparent cause. (2) Inherited osteo-psathyrosis is a term coined by German pathologists to indicate an inherited tendency to spontaneous fracture. It manifests itself in a multiplicity of fractures, occurring even in children; thus, a girl, aged twelve and a half years, had suffered from forty-one fractures since the second year of life. No explanation is given of this state, but the lesions seem to unite perfectly. (3) General bone diseases, such as rickets and osteo-malacia, also predispose to fracture; in those due to the latter affection there is usually no attempt at repair. (4) Local bone disease may also constitute an important predisposing factor by so weakening the bone as to lead to its fracture from a very slight injury. Thus, cancer and sarcoma of bone are often first recognised by causing an apparently spontaneous fracture, whilst manipulation of a limb which is the seat of caries or necrosis may lead to a similar result.

The **Exciting Causes of Fracture** are threefold: (1) *Direct violence*, the fracture occurring at the spot struck. The direction of such lesions is often transverse, and they are not unfrequently comminuted, or complicated with injuries to the adjacent soft parts. (2) When due to *indirect violence*, the bone gives way at a distance from the point to which the force is applied. The accident is usually produced by the compression or bending of the bone with such force as to exceed the limits of its natural elasticity, and it consequently yields at the weakest spot. Thus, when a person jumps from a height, the leg bones are compressed between the weight of the body and the resistance of the ground, and, if the violence is excessive, a fracture occurs at some point of mechanical disadvantage; if a person jumps from a carriage or train in motion, the same conditions obtain. Fractures produced in this way are often oblique or spiral in direction, and as the displacement may be considerable, there is great risk of them becoming compound. (3) *Muscular action* is most commonly the cause of fracture of small bones, or of osseous prominences into which powerful muscles are inserted. The patella and olecranon are not unfrequently broken in this way, the former often occurring from sudden and vigorous efforts to avert a fall. Occasionally the long bones, such as the humerus or clavicle, have been broken from violent muscular exertion, as from throwing a cricket-ball.

Intra-uterine Fractures may be caused by blows upon the mother's abdomen, or by abnormal or violent uterine contractions, especially if the liquor amnii is defective in amount; when multiple, they are usually due to fœtal syphilis. They may present any variety of deformity at birth, and may be partially or completely united. They must be clearly distinguished from malformations resulting from imperfect development.

Congenital Fractures are produced during birth by violence used by the accoucheur, or from excessive uterine contractions. They are most common in the thighs if due to traction, or in the skull if due to the pressure of forceps.

Varieties of Fracture.—Many terms are used to describe the multiplicity of conditions which may be met with in connection with a broken bone. The following are the more important: A **Simple Fracture** is one in which the skin is unbroken, or, at any rate, where the external air has no admission to the site of injury. A **Compound Fracture** is present when the skin or mucous membrane over the injured spot is lacerated, so that there is direct communication between the fracture and the external air. In the base of the skull, however, a fracture may open up one of the deeper air-sinuses, and thus cause it to become compound without any apparent external lesion.

Fractures are complete or incomplete, according to whether or not the continuity of the bone is entirely severed. Various forms of **Incomplete Fractures** are described. Thus, the *green-stick fracture* is one which only occurs in young children, and most often in those that are rickety; curved bones, such as the clavicle, are usually affected, and the fracture merely involves the convexity of the curve, whilst the concave half is bent, just as when a green bough or twig is partially broken. *Depressions* of the skull may be similarly incomplete when the outer table is driven in without fracture and the inner table alone splintered. *Fissured fractures* also are often only partial.

Complete Fractures may be *transverse*, though this is not very common; *oblique*, arising usually from indirect violence; *spiral*, when the fracture is due to a force acting longitudinally, but at the same time with a rotary movement superadded; it occurs most frequently in the tibia or femur. A *longitudinal* fracture is one due to fissuring or splitting of the bone in its long axis; it is most common in military surgery as the result of gunshot injuries; the neighbouring joints may or may not be involved. If it is combined with a transverse fissure, it is often termed T-shaped. *Comminuted* is a term used to describe the condition when the bone is broken into many pieces; *impacted*, when one fragment is driven into the other; *multiple*, when more than one fracture exists; *complicated*, when other important structures are damaged as well as the bone.

The **Separation of an Epiphysis** is not an uncommon occurrence in young people under twenty-two years of age. It results from injury or violence directed to the ends of the bones, but occasionally is more or less spontaneous or predisposed to by disease of the epiphysis or of the end of the diaphysis (*e.g.*, from inherited syphilis, or acute infective or tubercular epiphysitis). The ends of the femur, humerus, or radius are those most often affected. The line of cleavage usually runs through the soft spongy bone on the diaphyseal side of the cartilage, so that there is cartilage with spicules of bone on one side, and spongy bone on the other. The direction taken is in the main transverse, but most epiphyses are more or less concave or cup-shaped, the ends of the diaphyses being convex. The displacement is lateral, and resembles that of a dislocation. Union usually occurs readily by means of bone, but arrest of the longitudinal growth is likely to follow. This is a matter of special importance where one of the two bones of the lower leg or forearm is affected, since deformities of the hand or foot often result from the continued growth of the uninjured bone. Suppuration sometimes occurs as a sequela in unhealthy children, or when the accident is due to preceding disease of the epiphysis, and may result in an acute arthritis, possibly necessitating amputation of the limb.

Signs of Fracture.—The history usually given by the patient is that, as the result of some accident, he felt, or perhaps heard, something give way with a snap and experienced sharp pain, which became much intensified on attempting to move the limb. On examining the injured part and contrasting it with the opposite side, the following points are usually noticed:

1. The *signs of a local trauma*, viz., pain, bruising, and swelling, as a result of the effusion of blood from the torn and lacerated structures. The amount of this may be so great as to obliterate all the ordinary bony prominences and landmarks. Blebs and bullæ sometimes form in the course of a day or two on the surface of the skin over a fracture, and these should be carefully protected from injury. The bruising continues for some time, and may spread to parts far removed from the original mischief. It is very unusual for suppuration to occur after a simple fracture, but if the patient is very debilitated, and his germicidal powers diminished, auto-infection and abscess may result.

2. *Preternatural mobility in the continuity of the bone* may be demonstrated by manipulation, but never unnecessarily. Impaction of the fragments will prevent its occurrence.

3. Partial or complete *loss of function* also follows.

4. *Crepitus* is obtained by moving the limb and rubbing the rough ends against one another. It can only be felt when the

fragments are moveable and can be brought into contact, but not when there is wide separation or impaction. When an epiphysis has been detached, it is softer in character and more of a cartilaginous type.

5. Change in shape of the limb or *deformity from displacement* is almost always present. There are three chief factors at work in producing deformity, viz., the direction of the violence, the weight of the limb, and the contraction of muscles, whilst injudicious movement or rough handling may aggravate it. It is always, for obvious reasons, more marked in oblique than in transverse fractures, and hence is usually greater in those due to indirect violence. Various types of displacement are described, viz.: *Angular*, usually due to an increased curvature of the bone from the unantagonized action of powerful muscles; it is especially liable to obtain when the line of fracture is situated not far from the end of a bone, as in fracture of the upper third of the thigh; *lateral*, where the displacement is merely to one or the other side, and most common in transverse fractures; *longitudinal*, when one fragment overlaps the other or is forcibly driven into it, causing shortening of the limb; it may also occur in the form of wide separation of the fragments, as from contraction of the quadriceps in fracture of the patella; *rotatory*, when one fragment is twisted on the other, as in fractures of the femur, where the weight of the limb causes eversion of the lower end. In flat bones—*e.g.*, the skull—deformity may exist in the shape of *depression* or *elevation*.

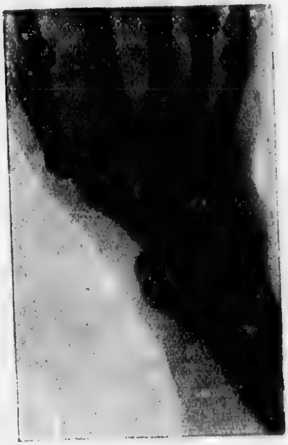


FIG. 98.—SKIAGRAM OF COLLES'S FRACTURE.

Such are the typical signs of a fracture, but it goes without saying that all of them are not present in every case, and that it is not always easy to ascertain the existence or not of such a lesion. Comparison with the opposite limb, and gentle manipulation to demonstrate abnormal mobility or crepitus, must be undertaken to settle this point, but no undue violence should be used.

The X rays have recently proved of the greatest advantage in these cases, and where there is any doubt as to the existence or not of a fracture, the limb should be at once skiagraphed. Fig. 98 is an illustration of the value of this proceeding; the case had been diagnosed by the practitioner as a simple sprain of the wrist, but the skiagram at once confirmed what had been suspected by the surgeon, viz., the existence of an impacted Colles's fracture. It is also possible by this means to determine whether or not a fracture has been rightly treated, and for this purpose it is quite unnecessary to remove plaster of Paris or splints, provided they are not metallic. Fig. 99 shows a forearm which had been operated on for an ununited fracture of both bones. The ends overlapped considerably, and portions were removed so as to bring the fresh surfaces into apposition, and the fragments were then wired. The skiagram was taken some days subsequently through dressings and splint; the tinned tacks in the latter are clearly seen, as also the loops of wire and the ends of the bones in apposition.

FIG. 99.—SKIAGRAM OF UNUNITED FRACTURE OF RADIUS AND ULNA AFTER OPERATION.

The bones are seen to be in apposition, and the silver wires are clearly evident. This skiagram was taken through dressings, bandages, and splint four days after operation. The tacks in the wooden splint come out quite distinctly.

General or Constitutional Results.—These may be divided into two groups:

1. **Immediate Effects**, consisting of shock and hæmorrhage. *Shock* is greater or less according to the amount of violence and the seat of injury. It varies from a mere passing faintness to the severest prostration. If the bones of the head or spine are injured, special symptoms due to concussion of the brain or injury to the spinal cord may also be produced. *Hæmorrhage*

always occurs either in simple or compound fractures, and it may progress to a considerable degree from laceration of important vessels or even of the main artery of a limb.

2. **Secondary or Remote Effects.**—*Fracture fever* is met with in the majority of all cases of fracture, commencing twenty-four hours after the accident and lasting two or three days. As a rule, it is not at all severe, the temperature rarely rising above 100° F. in uncomplicated cases, and the general signs of malaise, etc., are slight. It is a form of aseptic traumatic fever, probably due to the absorption of fibrin ferment. In compound fractures where asepsis is not attained, any form of wound infection may result, and even general septicæmia or pyæmia.

Delirium tremens is a not uncommon complication in fractures of the leg in debilitated individuals or habitual drinkers, such as brewers' draymen. The general characters and treatment of the disease are dealt with elsewhere (p. 208). As regards local treatment, the limb must be fixed by splints or some immoveable apparatus, and suspended in a Salter's sling so as to prevent the patient from moving the upper fragment independently of the lower.

The urine in fractures shows changes of which but little notice has been taken. (*a*) Urobilin is present in excess owing to the disintegration of the extravasated blood and the absorption of its derivatives. On the addition of chloride of zinc solution and ammonia, a fluorescent yellow-green colour results. (*b*) Fat is sometimes eliminated by the kidneys for a period which extends from the third to the twenty-first day. It is absorbed into the blood-stream from the breaking up of the medulla, and is excreted in the form of an emulsion, the molecules sometimes, however, running together into larger drops. The amount varies greatly in different cases. (*c*) Albumin is occasionally present for a few days, as also casts containing brown, nuclear-looking bodies, which are supposed to be the remains of red blood cells, absorbed from the local trauma and eliminated. Similar casts have been met with experimentally after injection of blood into the peritoneal cavity and after experimental fractures.

Fat embolism is a condition resulting from the absorption of broken-up fat globules after any injury which results in the contusion or laceration of fatty tissue. If at the same time there is, as in fractures, much hæmorrhage and local tension, this process is more likely to occur. As a general rule, no harm results, since the great mass of the fat is filtered off by the lungs or eliminated by the kidneys (as can be demonstrated after death by staining with osmic acid). The pulmonary obstruction may, however, become so great as to lead to a fatal issue from dyspnœa; whilst if the cerebral vessels are also blocked, syncope, or even coma, may be induced. The symptoms, which are gradual in their onset, usually commence about the third day, but may not be evident for a week or more.

Complicated Fractures.

1. **Comminution** of one or both fragments is an accident due to excessive violence, or perhaps to exceptional brittleness of the bones. As long as the wound remains simple, the surgeon need not be in any way disturbed by its occurrence, as sound union is usually obtained, though with an increased amount of callus; necrosis is practically unknown. In a compound fracture things assume a very different appearance, and serious mischief may result from the supervention of sepsis. No special treatment is called for in simple cases.

2. **Fracture implicating a Joint.**—In healthy individuals no untoward result is met with; the joint is for the time being filled with blood, which, however, is soon absorbed, and the fissure in the cartilage closed by plastic lymph. Adhesions are, however, very liable to form, and the subsequent mobility of the limb may be thereby impaired. Early passive movement and the breaking down of adhesions under chloroform may improve matters. If, however, the patient has a tubercular tendency, arthritis will possibly be lighted up. Osteo-arthritis may also be induced by an accident of this nature.

3. The same violence that causes the fracture may at the same time produce a **Dislocation** in a neighbouring joint. Treatment should be undertaken immediately; the limb is firmly fixed in splints commanding both fragments, and reduction attempted under chloroform. Failing this, consolidation must be allowed to proceed, and then the case dealt with as one of old-standing dislocation (p. 435). If, however, the fracture involves, or is close to, the articular end of the bone, as is not unfrequent at the elbow and shoulder, it may be advisable to operate at once, opening the joint, reducing the dislocation, and wiring the fragments; or possibly it might be better to remove the small detached articular portion. No absolute rules can be laid down to meet such cases, except the all-important one that such treatment is quite unjustifiable unless strict asepsis is maintained.

4. The **Main Artery** of a limb may be compressed, contused, punctured, or ruptured. The local results of this accident will be arterial thrombosis, with or without such an extravasation of blood as may impede the venous return. If the peripheral vessels are healthy, no permanent harm need result from this occurrence unless the vein is also implicated, and then moist gangrene is likely to supervene; an aneurism may, however, develop subsequently. If the terminal vessels are calcareous and rigid, so that there has been a preceding condition of chronic anæmia, dry gangrene will probably follow. For further details, see Chapters IV. and VIII. The **Treatment** to be adopted must necessarily vary in different cases. The correct rule to follow

would be to cut down in every case where the artery is punctured or ruptured, remove clots, and tie above and below the injury in the vessel; but, owing to the extensive laceration and displacement of the parts, it is not always advisable to follow this practice, and, indeed, it should never be undertaken without the most rigid asepsis. If it is considered unwise to lay the parts open, the main artery may be compressed or tied above the fracture, but only where the distal circulation has been re-established; in the absence of this condition, gangrene would be certain to ensue. If neither of the above-mentioned expedients can be adopted, an expectant plan of treatment must be followed. The limb is thoroughly purified, wrapped in aseptic wool, placed on appropriate splints, and slightly elevated. Should gangrene supervene, amputation is the only resort; it need not be undertaken for a few days if the limb is aseptic, so as to allow a distinct line of separation to form; but if septic, early removal through or above the line of fracture is essential.

5. Laceration of the **Veins** of a limb results in extravasation of blood, which is not so extensive as when an artery is wounded, from the fact that thrombosis is more easily determined owing to the lesser blood-pressure, but the congestion and œdema of the distal part of the limb which follow constitute serious additional elements predisposing to gangrene. Simple compression of the veins produces œdema, which, even in favourable cases, may persist for some time, needing for its removal firm bandaging, massage, and cold douching.

6. The **Nerves** of a limb may be injured at two different periods. (*a*) Immediate injury is due to laceration or rupture, either of the whole trunk, or, as is more common, of the nerve fibrillæ, without loss of continuity of the sheath. Paralytic and anæsthetic phenomena follow, but are usually recovered from. (*b*) Secondary symptoms result from the nerve becoming included in the callus, and compressed, as ossification ensues. It may also arise from injudicious splint pressure. Irritative symptoms in the shape of neuralgia and muscular spasms are first manifested, followed by paralysis and anæsthesia. This usually occurs about three or four weeks after the accident, and may persist or disappear in a month or two. **Treatment** is always of the expectant type for a time, so as to ascertain whether Nature will be able to repair the damage; and even when the paralysis is immediate, this course should be followed, since total rupture of a nerve is rare. When, however, the symptoms persist, the parts must be laid open, the nerve freed from adhesions, or exuberant callus removed, and such measures taken as will best secure the nerve from further compression and favour the process of repair.

Union of Fractures.

The union of fractures is brought about by a series of changes exactly analogous to those which we have already seen occur in other wounds, except that they do not terminate in the formation of cicatricial tissue, but go on to the further development of bone. The minute details of the process are even now not fully understood, although the main outlines can be readily indicated.

When a fracture has occurred, the broken ends of the bone are left rough, spiculated, and more or less separated one from the other; the periosteum is torn, the muscles and neighbouring tissues lacerated, and a varying amount of blood is extravasated. In the course of a few hours after the parts have been immobilized, the process of repair is inaugurated by the blood-clot becoming invaded by leucocytes, and after a time it is absorbed, the hæmoglobin passing through various stages of degeneration, and thereby staining the surrounding tissues. At the same time, a rarefying inflammation occurs in all the injured and lacerated structures, as a result of which the damaged parts are removed, connective-tissue corpuscles are set free and proliferate, and thus a cellulo-plastic exudation forms around and between the lacerated tissues and broken ends of the bone, which gradually become smooth, rounded, and devoid of spicules. This exudation is transformed into granulation tissue by vascularization from circumjacent vessels. Calcification of this material follows, preceded or not by a cartilaginous or fibrous change, and this calcified material is in its turn replaced by bone, which, at first soft and spongy, becomes after a time firm and sclerosed. In animals where the limb is not immobilized, a stage of cartilage formation always occurs before the final bony deposit, and this may also be met with in the human subject under similar circumstances, viz., in fractured ribs and not unfrequently in children, where it is difficult to keep the parts absolutely at rest.

This new cellulo-plastic material, known as *callus*, extends around the ends of the bone, which are, as it were, implanted in it and thus held together. In the early stages it is termed *provisional* or *ensheathing*, and the amount present is determined by the relative position of the fragments and the amount of mobility possible between them.

Where the broken ends are accurately apposed and the limb absolutely immobilized, but little callus is formed (Fig. 100, A), and that equally and evenly all round the site of the fracture. Ossification commences in that part of the ensheathing callus (*c*) which is farthest removed from the broken surfaces—*i.e.*, in the angle between the stripped-up periosteum and the bone—and gradually extends throughout the mass until the whole is consolidated, and thus the continuity of the bone is restored. At the same time, or a little later, the granulation tissue between the fractured ends, which extends for a short way into the medullary cavity (*b*), also undergoes gradual ossification, commencing in the medulla and gradually creeping down between the ends of the bone to join with the new bony tissue which is formed from outside. By this means is developed a lamella of new bone of variable thickness, which extends across the medullary canal and closes it, as also between the compact tissue on either side of it. The intramedullary portion is sometimes called the *internal callus*, and in favourable cases is subsequently removed, thus re-opening the medullary canal; that placed between the compact tissue of the fragments gradually becomes more and more firm, and is sometimes known as the *definitive callus* (*a*), and in many instances this is the only portion of the new tissue which finally persists. Indeed, it is by no means uncommon for the bone to be so absolutely restored as to show no signs of there having been a fracture.

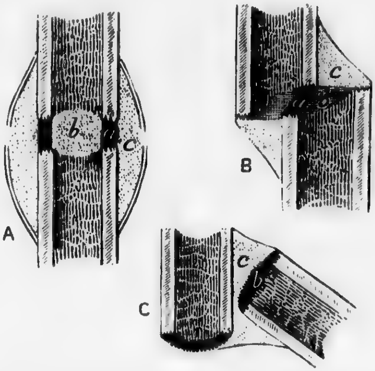


Fig. 100.—Diagram to represent Union of Fractures: A, when the Ends are in Close Apposition; B, when the Ends are only Partially Apposed; and C, when the Fractured Surfaces are not in Contact at all.

a, True or definitive callus; *b*, internal or medullary callus; *c*, external or provisional callus.

Where the ends of the bones partially overlap (Fig. 100, B), the amount of ensheathing callus (*c*) is correspondingly increased, and fills up all the spaces left by the over-lapping of the fragments. The projecting margins of bone are rounded off, and the medullary cavities closed by plates of internal callus (*b*); the amount of definitive callus (*a*) is usually small, but varies in amount with the actual conditions present. The main bond of union is the ensheathing mass. A certain amount of deformity is sure to remain after such an accident, and it is unusual for the medullary canal to be restored; frequently one or more plates of bone are found crossing it.

If the fractured ends are not placed in contact at all (Fig. 100, C), no definitive callus can be formed, but the medullary cavity of each fragment is closed by a plate of internal callus (*b*), and union is secured by a large mass of ensheathing callus (*c*).

Where comminution has occurred, the splintered fragments are matted together by an abundant formation of granulation tissue, which is subsequently transformed into callus.

The removal of the clot and the formation of granulation tissue usually take about a week or ten days, and calcification commences about the end of the second week. By the fourth or sixth week, according to the size and vascularity of the bone and the recuperative power of the individual, the fracture will be consolidated, but in the lower limb it is often eight weeks before the patient can bear any weight upon it. Months may, however, pass before the final stage of complete repair is attained.

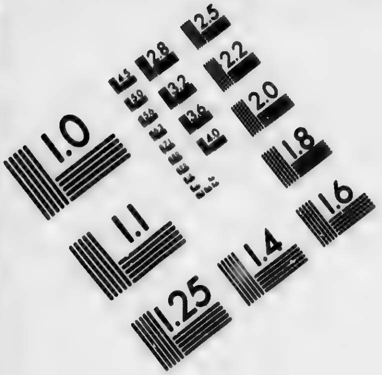
The **Treatment** of simple fractures is usually a matter of but little difficulty, although when the bones are much displaced or comminuted, it may not be easy to correct the deformity or to maintain the fragments in apposition. *Constitutionally*, all that is needed is to somewhat restrict the diet, eliminating all stimulating and unnecessary articles, at the same time attending to the state of the bowels. This is especially needed in fractures of the lower extremity, where the patient is confined to bed for some time. In elderly people the general health is very likely to suffer, partly from the shock of the accident, partly from the enforced and sudden change of habit, necessitating a somewhat generous diet and the administration of a certain amount of stimulant. The two great dangers threatening old people are hypostatic pneumonia and bedsores. Any tendency to the former is prevented by getting such patients into a sitting posture, and allowing them out of bed on crutches as soon as possible. Bedsores must be prevented by the strictest attention to cleanliness (p. 76).

The **Local Treatment** of a simple fracture consists, first, in *setting* the limb—that is, in reducing the deformity and restoring the fractured ends to a normal position—and then in *fixing* it so as to maintain it in the desired position.

First Aid.—If the patient has to be moved from the spot where the accident happened, it is necessary to temporarily secure the limb in as good a position as possible; splints have often to be improvised from sticks, umbrellas, newspapers, and so forth, so as to prevent any risk of the lesion becoming compound. In a railway accident the splintered débris of the carriages may be employed for this purpose, and the upholstery of the seats as padding. If one of the legs is broken, it may also be firmly tied to the other limb, which is thus converted into a temporary splint.

Reduction of a fracture is usually accomplished by a combination of extension applied to the lower segment of the limb, with manipulation of the fractured ends, counter-extension being at the same time maintained by an assistant. In some cases it is necessary to relax certain muscles in order to facilitate reduction; thus, in all fractures of the leg, the lower fragment tends to be drawn up by the muscles attached to the tendo Achillis, and to obviate this the knee should always be flexed by an assistant, who holds up the leg and makes counter-extension, whilst the surgeon reduces the deformity by traction on the lower part of the limb; section of the tendo Achillis is sometimes called for in these cases. The manipulation is often painful, but, if possible, an anæsthetic should be dispensed with, as one can never be certain whether or not the patient will struggle during its administration.

The maintenance of the limb in its normal position, when once reduced, is provided for by a suitable application of various **splints**. These consist of materials, such as wood, leather, zinc, poroplastic, etc., according to the requisites of the case. If of wood, zinc, or tin, they are usually made according to some general pattern, and fitted to the particular patient by means of pads; if formed of leather or poroplastic, they may be shaped so as to meet any peculiarities of the part. A pattern made of paper is first fitted to the limb, and the splint is then cut to the desired shape; it is softened by immersion in hot or cold water, moulded to the part, and allowed to dry on it. Where leather is employed, the addition of a little vinegar to the water assists in rendering it soft and supple. The edges and corners are finally rounded, and the interior padded with wool or lint. The general rules relating to the application of splints are as follows: (i.) The joints both above and below the site of fracture should always be immobilized; (ii.) the splints must be sufficiently large to firmly encase the limb, or, if flat, to project a little beyond it, so that the limb may be fixed by the splint, and not the splint by the limb; (iii.) careful attention must be given to the padding so as to prevent irritation or sloughing of the skin. In out-patient practice, where the patients are not too careful as to personal cleanliness, it is advisable to pad the splint with some antiseptic material, such as boracic lint, in order to prevent the development of vermin. It is sometimes stated that no roller bandage should be applied next to the skin under the splint in the situation of the fracture, and though this is a good general rule, it is not nowadays an invariable practice. The splints may often with advantage be first fixed to the limb by one or two turns of strapping, and then secured by ordinary calico bandages; these must not be applied too tightly, since the



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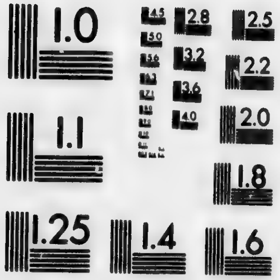

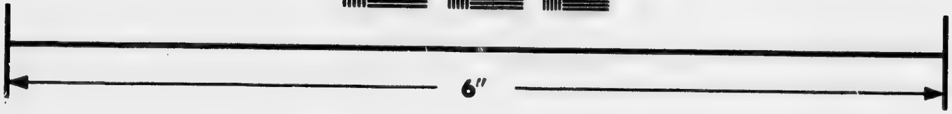

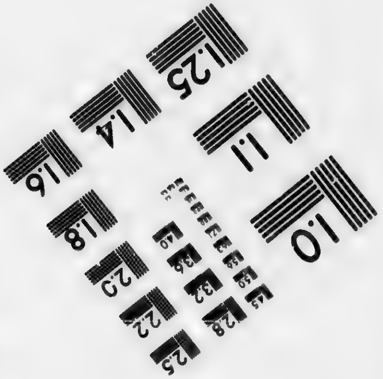

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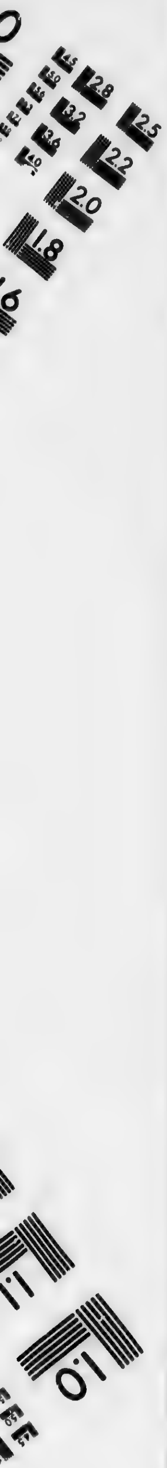
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swelling of the limb not unfrequently increases afterwards, and undue constriction resulting in gangrene may ensue. Moreover, a limb ensheathed in bandage must never be flexed, but the flexion should always be made before the bandage is applied; if this is not attended to, the bandage may cut into the soft tissues, and by compression of the vessels cause gangrene. It is sometimes necessary to bandage the peripheral parts of the limb, so as to prevent œdema from the pressure of the apparatus obstructing the venous return. The patient should always be seen on the day following the application of the splints, and the condition of the fingers or toes carefully examined; if they look at all blue, or feel numb and cold, the bandages must be slightly relaxed.

Various forms of **Fixed Apparatus** are occasionally used in the treatment of fractures, especially in the later stages when the swelling has disappeared, and in children. The materials most commonly employed are starch, water-glass, and plaster of Paris.

The *starch* bandage is only utilized in cases where great strength and rigidity are not required. The limb is carefully padded with cotton wool, and over this are applied thin strips of cardboard soaked in starch so as to fit the limb. This is secured by a bandage, the meshes of which are well impregnated with a starch solution, and over all may be placed another bandage, the under surface of which is also rubbed with starch. When this dries, it produces a firm mass, sufficient to immobilize the limb. It should be put on fairly tight, the wool padding, if thick enough, sufficing to prevent injurious constriction. Some surgeons employ it even in the early stages of fractures; under such circumstances, when the swelling of the limb diminishes and the bandage becomes loose, it must be readjusted by slitting it up and paring away a portion on one or both sides.

The *water-glass bandage* is applied by first swathing the limb with a thick padding of cotton wool, or bandaging it with boracic lint; around this a coarse canvas bandage soaked in a solution of silicate of soda, strong enough to be of the consistency of treacle, is applied; several thicknesses of the bandage are required in order to give it the necessary strength. The great advantage of this material is that it is light, easily applied, and makes but little mess; the chief objection to it is that it dries but slowly, taking fully twenty-four hours to become thoroughly hard and firm.

Plaster of Paris, though rather messy and increasing considerably the weight of the limb, is one of the best means of securing prolonged immobilization. It may be applied directly to the outside of a layer of cotton wool or boracic bandage; but frequently a coarse canvas bandage or a suitable piece of house-flannel is employed as a foundation on which to place it. (*a*) The dried plaster may be rubbed into a coarse canvas bandage, which prior to use is soaked for a few moments in cold water, to which a little salt may be added to prevent the plaster setting too quickly; it is then wound round the limb, which has been previously padded with boric lint or wool, and on the exterior of this fresh plaster of the consistency of cream is applied. To make this cream of the right strength, the dried powder is cast in spoonfuls into a bowl of cold water until it no longer sinks immediately, but a portion remains floating on the surface. The mixture is then stirred with an iron spoon, and is ready for use. (*b*) The so-called *Bavarian splint* is made by stitching together two pieces of coarse house-flannel sufficiently large to encase the limb, the seam being made so as to be situated down the back of the limb and in the middle of the flannel. By this means a double casing is provided on each side of the limb. The inner portions are applied closely to the part, and secured in front by a row of safety-pins; a thick layer of plaster is then spread over this, extending as far as the seam behind and to the junction of the two inner pieces in front. The outer layer of flannel is now drawn over this before it sets, and cut so as just to cover the plaster, reaching as far forwards as the inner piece. The two sides are dealt with in this way separately, and when the whole is firm, by removing the safety-pins, the splint can be taken off, the seam at the back forming a hinge. (*c*) Plaster of Paris may also be fitted to any part of the body according to a method introduced by Mr. Croft, of St. Thomas's Hospital. If required for a limb, pieces of flannel are cut into the shape of lateral splints, two for each side, and sufficiently large to encase it comfortably. After protecting the limb with wool or lint, one of the lateral segments, the outer side of which is well soaked with plaster, is placed in position, and the second portion, which has been totally immersed in the plaster, is then placed over it, a little extra plaster being perhaps rubbed in; the two are now secured by a muslin bandage. After this has set, the opposite side of the limb is dealt with in exactly the same way, and when the whole is solid the muslin bandage is cut through in front, but is left untouched behind so as to form a hinge. If it is considered necessary, thin strips of wood or metal may be incorporated in any of these arrangements, so as to add to their strength.

Early immobilization by means of plaster of Paris has been advocated by certain Continental and American authorities, and so much confidence have they in it that even fractures of the femur are dealt with in this way within a few days of the accident, and the patient allowed to walk about. Such *ambulatory treatment* has not received much support in this country, although we are beginning to realize that the old conservative plan of prolonged immobilization in splints is not always desirable. The practice followed is to secure the limb on both sides of the fracture for some considerable distance, incorporating metal supports in the plaster casing. To allow for the shrinking and atrophy of the limb which necessarily follows, the splint is early divided so as to allow of its frequent removal, and it can then be pared down and refitted to the limb; if this is not attended to, the ends of the fragments become loose, and are likely to move one on the other, possibly giving rise to non-union.

Another modification which has been recently advocated—especially by Lucas-Championnière—is the treatment of fractures by **Massage**. It has long been recognised that after an accident of this nature the limb is likely to remain for some considerable period weak and stiff, owing partly to atrophy of muscles, partly to cicatricial adhesions between various divided structures, and in part to contraction of ligaments in neighbouring joints. To prevent this, it has been proposed that splints should be entirely discarded, except in cases where displacement of the fragments cannot be otherwise prevented. The limb is allowed to lie on a soft sand-bag or pillow, or, in the case of the upper extremity, is supported in a suitable sling. Massage is commenced within a few days of the accident, being at first limited to mere rubbing movements, but subsequently including more forcible manipulation, and also passive exercise to the neighbouring joints; the séances are repeated daily, and gradually increase in length. A certain amount of pain is noticed at first, but this rapidly disappears, and, indeed, a sensation of comfort is induced by the exercises. It is claimed that by this means the period of treatment is much reduced, and that there is much less subsequent stiffness and disability. It must not be forgotten, however, that in the early stages, where blood-clot is still present, it is possible to dislodge a thrombus lying in a large vein, and certainly one fatal result has been reported from this cause; the greatest gentleness must therefore be used during the first week or ten days. Whether or not this plan of treatment is advisable in dealing with fractures of the shafts of long bones is still doubtful, but as to its value in fractures involving the articular ends there can be no question. For such injuries as fracture of the anatomical neck of the humerus, Colles's or Pott's fracture, and for fracture-dislocations in the neighbourhood of the elbow, it has been already proved to be of the greatest service. In one case of the first mentioned of these lesions, which we treated by this means at hospital, the result was most gratifying; the limb was merely kept in a sling, and massage was commenced within three days of the accident; within a fortnight the patient was able to raise his arm without help to a right angle, and he went out subsequently with a limb the movements of which were almost perfect. Similarly, in the simpler cases of Pott's fracture, all that is needed is daily massage and the fixation of the foot by strapping; in three weeks the patient can usually get about with the help of a stick.

Complications arising during Treatment.—(1) If an elderly patient is kept in bed for any length of time in the recumbent posture, *hypostatic pneumonia* is very likely to ensue. It occurs most commonly after intracapsular fractures of the cervix femoris, and owing to this cause non-union often results, since the patients have to be allowed to get about on crutches at an early date, the limb being fixed in a Thomas's splint. (2) *Bedsores* are very liable to supervene in old people with fractures which need treatment in the recumbent posture. (3) *Crutch palsy* is the result of compression of the brachial nerves between the head of the humerus and the pad of a crutch. It may affect all the nerves of the upper extremity, or may pick out any one of them, and then most commonly the musculo-spiral. It can usually be prevented by the use of spring padded crutches with cross-pieces for the hands, so as to allow the patient to partially relieve the axillary pressure by supporting the weight of the body by means of the arms. When it has occurred, the use of crutches must be discontinued, and faradism and massage employed to the affected muscles. (4) *Gangrene* may arise from fractures in a variety of ways: (i.) From the immediate effects of the injury, either by its direct action on the tissues, or by causing arterial thrombosis in a limb with atheromatous vessels, or from rupture of the artery with consequent venous thrombosis, owing to the pressure of the extravasation; (ii.) by the supervention of spreading gangrene in a compound fracture; (iii.) from errors in the course of treatment, as by bandaging the limb too tightly, so as to constrict the vessels; or by the bandage becoming unduly tight, owing to the subsequent swelling of the limb; or by flexing a joint after bandaging it, the bandage cutting into the soft tissues; or by the localized pressure of a splint which has been insufficiently padded. Moist gangrene is the type met with in all cases, except when the limb has been previously drained of its fluids by an atheromatous condition of its vessels. (For rules of treatment, see Chapter IV.)

Compound Fractures.

A compound fracture is one in which there is a communication between the external air and the site of injury. It may be produced by direct or indirect injury, and any of the complications or modifications met with in simple fractures may be present. The bones may be but little displaced, or may protrude through the opening in the skin, and under such circumstances may be much bruised or comminuted, and even contaminated with dirt or mud.

The chief dangers of compound fractures are, firstly, *hæmorrhage*, which, instead of collecting within the tissues of the limb, is able to escape externally, although subcutaneous extravasation is not uncommon; and secondly, the advent of *sepsis*. The latter is the more important, and may lead to the most serious consequences. Portions of muscle and periosteum, which in a simple fracture would be removed or incorporated in the new formation of callus, may in septic cases become inflamed, and even slough. Small isolated fragments of bone are almost certain to necrose if suppuration ensues, whilst the severest forms of septic osteomyelitis may occur, endangering the patient's life by pyæmia. Such results are exceedingly prone to follow when the external wound is small and insufficient provision has been made for drainage. Immense advances in the treatment of these conditions have been made since the introduction of antiseptic surgery, and where such is regularly and efficiently practised, these dangerous complications are rarely seen.

The **Method of Union** of a compound fracture is practically the same as that occurring in simple fractures. If the wound can be rendered aseptic, and there be not much bruising, it may be closed by suture except at the spot where a drainage-tube is inserted. Primary union may thus be obtained, and then repair according to the details already described will result. If, however, suppuration occurs, it will probably be attended with a greater or less amount of necrosis, and possibly diffuse suppuration in the soft parts; the wound will therefore remain open for a time, varying with the acuteness of the local phenomena. It is gradually closed by granulations, which extend upwards from below, and the deepest part of this granulation tissue, which is derived from the bone and periosteum, and contains osteoblastic elements, will be transformed into callus, and finally into true osseous tissue.

The **Constitutional Reaction** following compound fractures is always more marked than in simple cases. Even where sepsis is prevented by efficient treatment, a certain amount of aseptic traumatic fever is almost certain to supervene for a few days; whilst, if sepsis occurs, there may be a period of marked febrile disturbance for a week or ten days, similar to that which is seen in all septic lacerated wounds (p. 90).

In the **Treatment** of compound fractures, the main object of the surgeon is to render the wound aseptic and to give efficient exit to the discharges. For this purpose the patient should in many cases be anæsthetized, the wound enlarged and thoroughly washed out with some potent antiseptic, such as carbolic lotion (1 in 20). Where dirt has been ground into the soft tissues, or even into the bone, the surgeon need not be afraid of scrubbing the parts with soap and an antiseptic solution by means of a nail-brush. Loose fragments of bone are removed, and portions denuded of their periosteum may be taken away lest necrosis should ensue; but, as a rule, where fragments retain any considerable connection with the soft parts, they may be left without fear. When a sharp end of one of the fragments is protruding through a small opening in the skin, it is first thoroughly purified before attempting its reduction, and is then either replaced, after enlarging the wound in the skin, or a portion sawn off. Hæmorrhage from definite spots is dealt with in the usual way, and the fragments placed as nearly as possible in their normal position. If there is no comminution and the fragments can be brought accurately into position, they may require fixation by the insertion of silver wire, when it is probable that asepsis has been attained; but where the ends of the bones are comminuted, the small portions must be arranged in position as well as possible, and no attempt made to wire them. A good-sized drainage-tube is inserted, and, if need be, counter-openings made; the limb is then placed on appropriate splints, and the external wound may be closed or not according to circumstances. Under such a régime the majority of uncomplicated cases will do well. Immoveable apparatus may be applied after a time, windows being left in the plaster casing to allow any wounds to be dressed.

In compound fractures which have been attended with complications directed to vessels, nerves, and neighbouring soft parts or joints, the prognosis and course of the case may be considerably affected; treatment suitable to each of these conditions must be adopted (p. 364).

The question of **Amputation** will necessarily be raised in the more serious cases; but it is unnecessary to add anything here to what has already been stated in Chapter VII. (p. 181).

Ununited Fractures.

Three varieties of ununited fracture have been described: (1) *Absolute non-union* is said to be present when no attempt at repair is made. This rarely occurs except when some definite bone disease, such as sarcoma or osteo-malacia, exists, or when in a very debilitated patient there has been no attempt to fix the limb. (2) *Fibrous union* consists in the development of a more or less firm mass of connective tissue, which serves as the only bond of union between the ends of the bones, which are either rounded and closed by a thin plate of bone or cartilage, or sometimes pointed and atrophied. (3) A *false joint*, or pseudarthrosis, is a condition in which the ends of the bones are covered either by bone or cartilage, and more or less altered in shape, so as to form a shallow ball-and-socket joint, the capsule being represented by the surrounding fibrous tissue, and the synovial cavity by an adventitious bursa, which forms as the result of the friction of the two ends (Fig. 101).

The most common situations for ununited fractures are projecting processes of bone to which powerful muscles are attached, such as the patella, olecranon, coracoid process, posterior half of the os calcis, etc.; whilst in long bones the middle of the shaft of the humerus and the upper and lower thirds of the femur are the favourite sites.

Many different **Causes** may be associated in determining the defective union of fractures, but the following are the more important: (1) Want of apposition of the bony ends, owing to muscular action—*e.g.*, in the patella, where the two fragments may be widely separated, or in the femur, where they may overlap; (2) the interposition of foreign bodies, such as muscular or aponeurotic tissue; (3) want of rest, one of the most common causes, as in the middle of the shaft of the humerus, where, unless the elbow is well supported, complete immobility cannot be obtained, and non-union is likely to result; (4) defective blood-supply to one or both fragments, as by injury to the nutrient artery, or as in intracapsular fracture of the cervix femoris, where the only source of supply to the upper fragment is a small twig derived from the obturator artery running along the ligamentum teres; (5) local affections of the bone, such as malignant tumours, destruction of the periosteum by inflammation, or the undue pressure of pads upon the newly-formed callus; (6) general bone disease, as osteo-malacia; and (7) general constitutional weakness or debility, sometimes due to definite diseases, as scurvy or severe syphilis, sometimes to general asthenia or alcoholism. It has been definitely proved that senility, pregnancy, and the cancerous cachexia do not, as used formerly to be stated, predispose to this condition.

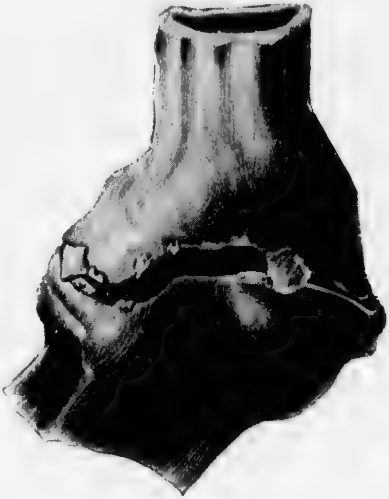

FIG. 101.—UNUNITED FRACTURE WITH FALSE JOINT. (FROM COLLEGE OF SURGEONS' MUSEUM.)

The **Signs** of an ununited fracture are perfectly obvious, as a rule, mobility between the two fragments being obtained, although without crepitus.

The **Prognosis** is usually good if suitable treatment is adopted. In the case of children, however, the condition is often maintained even after operative treatment, and, in fact, may be aggravated by it, the ends of the bone becoming atrophic, rounded, and covered by cartilage; in such the final resort is not unfrequently amputation.

The **Treatment** of ununited fractures is now conducted on perfectly definite lines. (1) The parts are refixed in an immoveable apparatus, preferably plaster of Paris, for six weeks, whilst means are adopted to improve the general health, as by a stay at the seaside and the administration of tonics. (2) Failing this, the ends of the bones may be well rubbed together, so as to excite local action, and the parts again fixed. (3) Should this be unsuccessful, operative measures must be undertaken. If the bone is tolerably superficial, and the ends not very far apart, they should be exposed, sawn into shape, fitted together (preferably by a dovetailing process), and secured by stout silver wire, which may be left *in situ* permanently, and if aseptic becomes encapsuled. If, however, the bones are deeply placed, so that the operation to expose the ends and fit them together becomes a very severe one, it is often better practice to leave them in their bad position, and merely fix them by the insertion of ivory pegs or nickel-plated screws. Thus, in the upper end of the femur non-union is usually associated with overlapping of the ends of the bone to a considerable extent. To expose and fit these together would necessitate a very extensive operation; it is wiser in such cases merely to cut down in front upon the upper anterior fragment, drill two holes through both fragments, and into these insert suitable ivory pegs. Two holes should always be employed, to prevent slipping of the fragments during the many necessary manipulations; whilst one drill is removed for the insertion of the peg, the other holds the bones steady. As a rule, the pegs may be allowed to remain permanently, but occasionally they become loose in three or four weeks, and need removal. Their presence causes a large amount of callus to form, and by this means the fracture is consolidated.

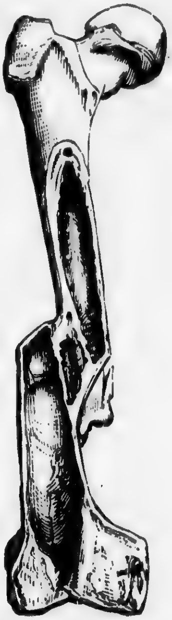

FIG. 102.—OLD FRACTURE OF FEMUR WITH VICIOUS UNION.

Disunited Fracture is the term applied to a rare condition, in which a fracture which had been apparently firmly united becomes separated again. It is only met with when the individual develops some extremely debilitating disease, such as scurvy; it may be recovered from under suitable treatment directed to the cause, and by fixation of the parts.

Vicious Union of fractures results either from imperfect readjustment of the ends of the bone prior to placing the limb on an immoveable apparatus, or from the parts not being kept at rest, and hence becoming subsequently displaced. Various kinds of deformity and disfigurement, accompanied or not by loss of function, may result from this accident. In some cases it may be advisable to leave things alone, but where the deformity or functional disturbance is serious, means must be taken to remedy matters. If observed early, it is not difficult to readjust the parts by simple pressure under an anæsthetic, if necessary re-fracturing the bone; but this should only be undertaken whilst the callus is soft, *i.e.*, within three or four weeks of the accident. Some surgeons apply this method of *osteoclasia* even when consolidation has been accomplished, using for the purpose levers and powerful clamps; but in our opinion such treatment is most undesirable and highly unscientific, since it is difficult to accurately gauge the amount of damage concurrently inflicted on the soft parts. We much prefer the *open* method, cutting down on the bone, redividing it, removing unnecessary callus, and fixing the fragments by silver wires, pegs, or screws.

Special Fractures.

Bones of the Face.—The **Nasal** bones are always broken as a result of direct violence, by the fist, a cricket-ball, stick, etc. The fracture is generally transverse, and situated just above the free margin of the bones; occasionally, when greater force is used, they give way close to the root of the nose, and may then be complicated with fracture of the frontal bone or base of the skull. In young people the cartilages alone may be separated. There is usually a good deal of deformity from depression or lateral displacement of the fragments, although it may at first be masked by the amount of bruising present. Severe epistaxis, surgical emphysema, and cerebral symptoms, are sometimes met with as complications of these cases. The fracture very readily becomes consolidated, and the deformity is thus often irremediably fixed. It is most important, therefore, to determine the presence or not of a fracture at once, and this can only be made out when much swelling is present by grasping the organ and moving it from side to side to elicit crepitus. The **Septum** is sometimes broken and depressed in association with the above injury, but it may occur alone in other instances, giving rise to lateral displacement. This need not result in obvious deformity, but may lead to considerable nasal obstruction and discomfort. The **Treatment** of these cases consists in immediate replacement of the bones, advisably under an anæsthetic; this may be accomplished by the pressure of some blunt instrument, such as a pair of padded dressing forceps, the blades of which are introduced within the nostril, or by distension of a suitable indiarubber bag with air or water. A pad of lint or gauze soaked in carbolic oil is then inserted to maintain the position, and a guttapercha or zinc splint moulded to fit the bridge applied externally. In old-standing cases, where there is much depression of the bridge, but little can be done, although it is possible to divide the septum by Rouge's operation (p. 693), and then forcibly elevate the parts, maintaining them in position by suitable plugs or vulcanite supports. Lateral deformity can usually be remedied by mechanical appliances or operation.

The **Lachrymal** bone has been broken by direct violence, the fracture usually extending from the nasal bone to the lateral mass of the ethmoid. Interference with the flow of tears and surgical emphysema are the two most marked symptoms.

The **Malar** bone is but rarely fractured without the other bones of the face being involved. When it does occur, it is almost always associated with damage to the anterior wall of the antrum, and considerable depression of the fragments results. An attempt should be made to replace the parts by pressure from within the mouth.

The **Zygoma** may be fractured by direct violence applied from without; the broken portion may be depressed below the surface, but vertical displacement is limited by the attachment of the masseter below and of the temporal fascia above. Reposition, either by manipulation from within the mouth, or even by operation, is essential in order to prevent interference with the subsequent mobility of the jaw.

The **Superior Maxilla** is invariably broken as a result of direct injury, such as a gunshot wound or a blow; it is almost always compound, and often bilateral. The alveolar portion is either partially or entirely detached, or a transverse fissure, extending as far as the pterygoid processes on each side, may render the whole palate and lower part of the facial skeleton moveable. Not unfrequently all the bones of the face are smashed and comminuted, severe hæmorrhage from the internal maxillary artery or its terminal branches sometimes resulting. As a rule, **Treatment** consists in merely keeping the patient quiet and applying cooling lotions; union occurs with great readiness, but is sometimes associated with necrosis and suppuration. The patient must be fed by a tube, and a carefully fitted dental plate should be applied to a broken alveolus.

The **Inferior Maxilla** is usually fractured by direct violence, but occasionally by force applied indirectly, as when a carriage passes over the bone, laterally compressing the two sides, and leading to a fracture in the middle line. Most often the site of the lesion is a little in front of the mental foramen (Fig. 103), this being a weak spot at the junction of two strong parts, viz., the symphysis menti and the alveolus carrying the molar teeth; the bone is further weakened by the long narrow alveolus lodging the canine tooth. This fracture may sometimes be double when great violence has been applied to the symphysis. A solution of continuity also occurs close to the angle behind the molar teeth, whilst the coronoid process and condyle have occasionally been broken, the former only as a result of great force, *e.g.*, a gunshot wound, the latter from either direct or indirect violence.

The **Signs** of this fracture are very evident if the lesion is situated anteriorly; but when behind the teeth, diagnosis may be much more difficult. The common variety is almost always compound, owing to the firm attachment of the muco-periosteum to the alveolar border. Laceration of the gums, the blood-stained saliva soon becoming fœtid, the irregularity in the line of the teeth, and the easily elicited crepitus, all constitute a typical picture. There is usually considerable pain, owing mainly to the tearing of the mucous membrane, but possibly due to implication of the inferior dental nerve. The main trunk, however, generally escapes, owing to the position of the fracture in front of the mental foramen, whilst in those behind there is but little displacement. Smart hæmorrhage sometimes occurs from laceration of the accompanying artery. The posterior fragment is usually somewhat raised, whilst the anterior portion is depressed by the action of the hyoid muscles, and may override the former, owing to the direction of the fracture, the anterior fragment including more of the outer surface of the bone than the posterior. The direction of the displacement is reversed in some cases. When situated at the angle or *in the vertical ramus*, there is such equal muscular support on the two sides that but little displacement results. When the fracture passes *through the neck of the condyle*, that process is displaced forwards and inwards by the external pterygoid, whilst the body of the bone is freely moveable antero-posteriorly, and drawn over towards the opposite side. When the *coronoid process* is detached, it is dragged upwards by the temporal tendon, but no great displacement can occur, owing to the extensive attachment of the tendinous fibres.

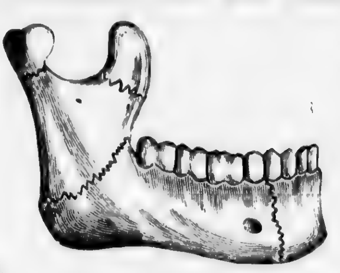

FIG. 103.—LOWER JAW, INDICATING THE SITE OF THE MOST COMMON FRACTURES.

In those cases of fracture which are compound (and this includes the great majority of those ordinarily seen), a septic inflammation of the ends of the bone often ensues, leading to localized necrosis, and sometimes to septic pneumonia, or even to general pyæmia.

The **Treatment** of a fractured mandible is frequently a matter of difficulty, owing partly to the septic element present, and partly to the difficulty of fixing the jaw without interfering with the patient's nutrition. A great variety of methods have been therefore suggested, but of these the following are the more important:

1. In simple cases, without much displacement of the fragments, all that is needed is an efficient four-tailed bandage. This is made by taking a piece of calico 4 inches wide and 1 yard in length, and splitting each end into two, leaving about 8 inches undivided, and in the centre of this a small longitudinal cut is made, into which the point of the chin is inserted. The two lower tails are then drawn up and tied over the vertex, whilst the two upper ends are secured behind the occiput, and then, to prevent slipping, are knotted to the ends of the former (Fig. 104). If the lower knot is brought below the protuberance, backward displacement of the anterior fragment may be produced, and subsequent deformity. This apparatus should be maintained firmly in position for three weeks, the patient being fed on fluids passed between the teeth or through the gap behind the last molar, and all talking and attempts at movement prohibited. The mouth should also be frequently syringed out with some antiseptic lotion. Firm union is usually secured in five weeks.

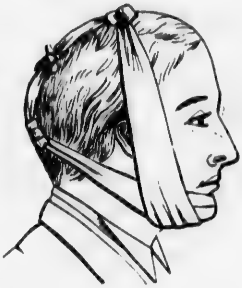

FIG. 104.—APPLICATION OF FOURTAILED BANDAGE FOR FRACTURE OF LOWER JAW.

2. If patients are inclined to be unruly, or if the above apparatus fails to maintain the fragments in position, a moulded guttapercha or leather splint may be applied, made in the shape indicated in Fig. 105, the upper portion being folded back, and the lower portion drawn up around the bone. It is lined with lint, and secured by bandages or tapes passed through holes, and tied as shown in Fig. 106.

3. Where there is much displacement, the fragments must be fixed. Wire sutures passed around or between the teeth and tied are distinctly objectionable, causing the teeth to become loose, and perhaps diseased. *Hammond's wire splint* has been much praised, but we cannot speak of it from personal experience. It consists of a firm wire collar or framework, which encircles the whole series

of teeth in the lower jaw. It is accurately fitted, firstly, to a cast of the jaw, subsequently to the jaw itself, and is fixed by several wires passing from one half to the other between the teeth.

4. *Wiring of the fragments* together may be required in a few cases. The wires must be passed either through the bone below the teeth—a task not easy to accomplish without an external wound—or through the empty alveoli of neighbouring teeth, which are extracted for the purpose.

When septic inflammation occurs of such severity as to lead to necrosis, it is often best to delay all operative treatment until the sequestrum has been detached, and the parts are more healthy, the patient's mouth in the meantime being frequently cleansed with antiseptic lotions. Wiring of the fragments may then, if necessary, be undertaken with good hope of success.

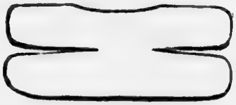

FIG. 105.—LEATHER SPLINT FOR LOWER JAW.

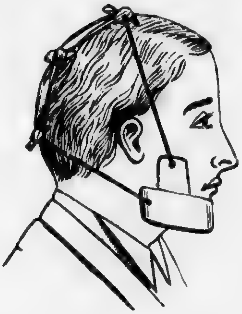

FIG. 106.—LEATHER SPLINT APPLIED.

Fracture of the Hyoid Bone is uncommon, arising usually from direct violence, such as a forcible grasp or the constriction of the neck in hanging. Either the body may be broken, or one of the cornua separated. The symptoms produced are: Pain on attempting movements of the tongue, jaw, or neck; a husky voice; and deformity, which can sometimes be detected from without. Occasionally the mucous membrane is perforated, and bleeding into the mouth may occur, whilst œdema of the glottis may subsequently supervene. The fragments should be approximated as well as possible by manipulation between one finger in the mouth and the hand outside, and the neck then fixed by a poroplastic collar.

Fracture of the Ribs may arise in two distinct ways: (1) By direct violence, as by blows or stabs, the fragments being driven inwards, and damage to the underlying pleura, lungs, liver, or diaphragm, being very likely to occur; or (2) by indirect violence from external pressure, as when the chest is compressed between a cart-wheel and the ground, or between a wall and the end of a waggon. The two ends of the rib are then approximated beyond the limits of natural elasticity, and it gives way at the most convex part—*i.e.*, near the angle. Damage to the viscera may arise from contusion, but is less common than in the former class, although hæmothorax from rupture of the parietal pleura is not uncommon. One or several ribs may be broken, but the displacement is rarely marked, except in cases due to direct violence where several ribs have been 'staved in.' The fifth to the eighth ribs are those most commonly injured, being more prominent and fixed at both ends; the first and second ribs are so well protected by the clavicle as to be seldom broken, and then only by direct violence, whilst the lower ribs often escape on account of their greater mobility. Elderly women and persons suffering from general paralysis are specially prone to this accident.

The **Symptoms** are usually tolerably obvious, viz., a sensation of something snapping or giving way, a sharp localized catching pain at the site of the injury, increased on deep breathing and coughing, and possibly some local extravasation and swelling. The pain may also be elicited by conjoined pressure upon the sternum and spinal column, whilst the fracture may be evident on palpation, or crepitus detected when the patient coughs or on auscultation. When several ribs are driven in, a marked depression may result, whilst if the bone is well covered with fat or muscle the diagnosis may be extremely obscure. For the clinical history of cases complicated by lesions of the lungs or pleuræ, see Chapter XXVII.

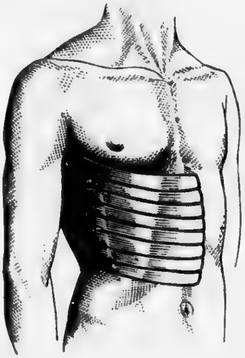
FIG. 107.—METHOD OF STRAPPING BROKEN RIBS.

The **Treatment** is tolerably simple. The affected side is to be securely strapped with broad strips of adhesive plaster, so as to limit the movements as much as possible. The strips, 1½ to 2 inches wide, should project beyond the middle line, both front and back, and are applied from below upwards whilst the chest is in a state of forcible expiration, each strip overlapping the preceding one (Fig. 107). A firm woollen bandage should then be applied over all. If the ends of the bone are driven inwards, such strapping can rarely be borne, as it tends still further to irritate or compress the lung. Under such circumstances all constriction of the chest should be avoided, but the patient should be confined to bed with a sandbag between the shoulders, and the arm bound to the side. When the lower ribs are broken, tight applications are generally contra-indicated, since the diaphragm is likely to be irritated, and troublesome hiccough may result. Ribs, as a rule, unite readily, but a considerable amount of callus is formed owing to the difficulty of satisfactorily fixing the broken ends.

Separation of a Costal Cartilage sometimes occurs, giving rise to the same symptoms and requiring the same treatment as a broken rib. Occasionally the cartilage itself may be fractured. In each case the resulting bond of union is osseous.

Fracture of the Sternum is almost always due to direct violence, although it has been known to yield from excessive flexion of the body after fracture of the spine, or from muscular violence during parturition. The line of fracture is usually transverse, the bone giving way either between the manubrium and gladiolus, or a little below this line. The bones may remain *in situ* or the upper fragment be displaced backwards, the deformity in such cases being very evident, and great dyspnœa resulting. As a later effect, aneurism of the arch of the aorta may occur.

Treatment.—The patient should be kept in bed with a pillow between the shoulders, and the chest strapped as for fractured ribs. If the patient cannot bear this position, he should be allowed to sit up with the body leaning forwards. Reposition can sometimes be effected by manipulation and extension of the spine; at present no operative measures have been undertaken with this motive, although there is no absolute reason why it should not be attempted.

Fractures of the Upper Extremity.

Fracture of the Clavicle.—No bone in the body, with the exception of the radius, is broken more frequently than the clavicle; this is due to its exposed position and its buttress-like action in keeping out the point of the shoulder, so that every shock to the arm is transmitted through it to the trunk. Hence, although fractures from direct violence do occur, it is more usually broken as the result of force directed to the hand or shoulder, such as a fall from a horse. The injury is very common in children, being then often of a greenstick nature, and more frequent in men than in women. The bone may yield in four different spots, viz.:

1. **At the Sternal End,** an uncommon occurrence, and often of the nature of a separation of an epiphysis, and hence generally seen in children. The displacement is very slight, as the outer fragment is almost immoveably fixed by the rhomboid ligament.

2. **Through the Greater Convexity,** the commonest situation. The bone yields about its centre, and the line of fracture is

slightly oblique, running from without backwards and inwards. The displacement that occurs is quite characteristic, and is present in any fracture situated between the rhomboid ligament on the inner side and the coraco-clavicular ligaments on the outer, being less marked, however, when the fracture is nearer the extremities than the centre of this space. The patient presents himself with a history of injury and severe pain, supporting the elbow with the other hand, the head bent over to the affected side, so as to relax the muscles of the neck, and the arm powerless. On closer examination, one finds that the point of the shoulder is less prominent than usual, being approximated to the sternum, and on a lower level than the other, whilst at the site of fracture is a slight bony projection. This deformity is accounted for by a displacement of the whole outer fragment downwards, forwards, and inwards (Fig. 108); the outer end, however, is more displaced than the inner, so that the latter looks upwards, inwards, and backwards, although it is placed immediately below the inner fragment. Such deformity is mainly due to the weight of the arm acting upon the outer fragment when the buttress-like action of the bone is gone, allowing the venter of the scapula to embrace the curved thoracic wall, from which it is usually kept separated. The action of the muscles passing from the trunk to the upper arm may have some effect, but can only be looked on as an accessory, and not the main cause of the displacement. The position of the inner fragment is probably but little altered, since it is held in place by the rhomboid ligament; the apparent projection of its outer end is due rather to the depression of the outer fragment than to elevation of the inner by the sterno-mastoid.

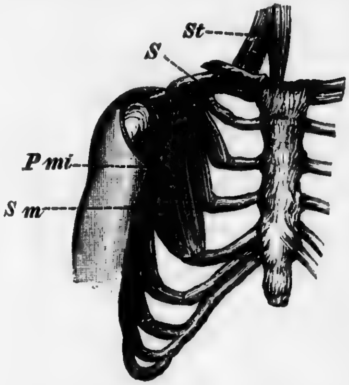

Fig. 108. — Fracture of Clavicle through Greater Convexity. (Tillmanns.)

St, Sterno-mastoid; S, subclavius; P mi, pectoralis minor; S m, serratus magnus.

3. **Between the Coraco-clavicular Ligaments**, usually arising from direct violence, and with but little displacement, owing to the tension of the ligaments. The signs of local trauma and crepitus are, however, present.

4. **At the Acromial End**, external to the trapezoid ligament, and, again, usually produced by direct violence. The inner frag-

ment here retains its position unaltered, but the outer fragment is dragged down by the weight of the arm, and forwards by the action of the muscles, so that it lies at right angles to the rest of the bone.

Complications arise most frequently in cases produced by direct violence. The subclavian vein may be injured, or the brachial plexus; and even the dome of the pleura and the subjacent lung have been injured. Gangrene of the arm has resulted from obstruction to the vessels.

Treatment.—In the first and third of the above-mentioned varieties, all that is needed is to immobilize the arm in a sling and to keep the patient quiet. In the last form a figure-of-8 bandage is required around the shoulders to keep the outer fragment back, and an elbow sling to keep it up.

For the ordinary type of fracture many different plans of treatment have been adopted. In order to replace the fragments or to set the fracture, the surgeon should stand behind the patient, who is seated, with his knee between the scapulæ; traction is then made upon the shoulders, and the point of the acromion is thus drawn upwards and backwards, after which the two fragments can be readily manipulated into position. To maintain this position the following methods have been recommended: (*a*) The simplest, which can always be applied on an emergency, and perhaps the best even for a permanent application, is that known as the *three-handkerchief plan*. Two large handkerchiefs, folded double and rolled into bands, are placed vertically, one over each shoulder and under each axilla; each is lightly knotted behind, and then firmly tied to the opposite handkerchief across the middle line. By this means the point of the shoulder is kept outwards and backwards. The third handkerchief is now folded crosswise and used as a sling to support the elbow, which is drawn well forwards, the hand being placed over the sound clavicle. If this apparatus is employed permanently, the knots must be examined every few days, especially at first, as the handkerchiefs always give a little, and require occasional tightening. (*b*) *Sayre's method* by adhesive plaster is exceeding useful, especially in treating children. A long strip of adhesive plaster, 3½ inches wide or less, according to the size of the patient, is passed round the arm a little below the axilla, as a loop, with the sticky side out, and then around the body with the adhesive side inwards, the arm being drawn well back, and the loop and ends firmly secured by stitches. If this has been applied sufficiently tightly, it may now be used as a fulcrum, so that as the elbow is drawn forwards, the point of the shoulder is directed backwards and outwards, and thus the main deformity is overcome. Another strip of a similar width is applied over the elbow (a small hole being cut to receive the point of the olecranon), and by this means the arm is raised and drawn forwards and the hand placed on the opposite shoulder, and the desired position is thus maintained (Fig. 109). In children more than one strip of plaster will be needed in order to secure the arm. Excellent results follow this plan of treatment. (*c*) In young ladies, where the absence of even the slightest deformity is desirable, it is better to confine them to bed; the head is kept low without a pillow, and a sandbag placed between the scapulæ, the arm being bandaged to the side. This position must be maintained for three weeks, and even then only very limited movement allowed. (*d*) The old-fashioned plan of treatment by means of an axillary pad, a figure-of-8 bandage crossing behind the shoulders, and an elbow sling, has to a large extent been superseded by Sayre's and other methods. It has nothing to recommend it, and many disadvantages. (*e*) Special apparatus, such as Ellis's splint, is sometimes used, but is scarcely needed if the application of the above methods is mastered. Union is probably attained in four weeks, but the movements of the arm should be restricted for some time longer. A considerable amount of callus is usually formed, and there is very likely to be some slight persistent deformity.

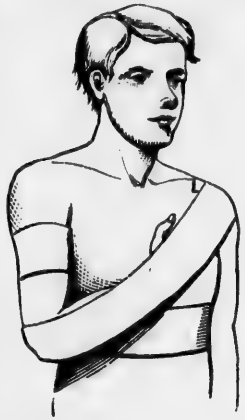
FIG. 109.—SAYRE'S METHOD OF STRAPPING FOR FRACTURED CLAVICLE.

Fractures of the Scapula.—1. The **Acromion Process** may be broken by direct violence applied to the point of the shoulder. The arm hangs powerless at the side, supported by the other hand, and the shoulder is flattened. The irregularity of the bone can be readily detected by running the fingers along the spine of the scapula, and crepitus can be elicited by raising the elbow and rotating the arm. Occasionally merely the tip is detached, and then the above signs will not be present. The **Treatment** consists in raising the elbow, and bandaging the arm to the side.

2. The **Coracoid Process** is rarely fractured, and only from direct violence. There is but little displacement, on account of the many powerful ligaments attached to it, and all the treatment needed is to raise the arm by a sling, and to keep it at rest by the side.

3. The **Body** of the scapula is broken as a result of considerable direct violence, which also bruises the thick muscles overlying it. As a rule, there is but little displacement, especially if, as is usually the case, the fracture is transverse just below the spine. A longitudinal fracture may, however, result in displacement of the inner or vertebral fragment upwards and outwards in front of

the axillary portion, owing to the action of the serratus magnus and levator anguli scapulæ; considerable deformity is caused by this accident. The diagnosis is made by grasping the bone firmly above and below, and moving one fragment on the other; crepitus may thus be obtained. The **Treatment** consists in bandaging the arm to the side, and possibly applying strapping to support the fragments.

4. When the **Neck** of the bone is fractured, it usually gives way as a result of indirect violence. A portion of the articular surface is broken off in some few cases of dislocated shoulder, and displaced downwards (Fig. 110); or the fracture has been known to run through the anatomical neck, either condition causing slight lengthening of the arm, and displacement of the head of the humerus into the axilla, as in a subglenoid dislocation. **Treatment.**—The arm must be kept to the side and raised.

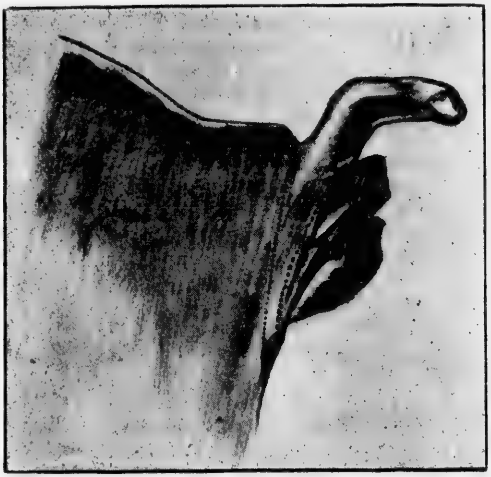

FIG. 110.—FRACTURES OF NECK OF SCAPULA.

More commonly, however, the fracture involves the **Surgical Neck**, extending from the suprascapular notch above to just below the origin of the triceps muscle, so that the detached fragment includes the coracoid process. Flattening of the shoulder results, with prominence of the acromion, lengthening of the arm as measured from the acromion to the external condyle, and crepitus on raising and rotating the limb. The treatment of such a case consists in replacing the bone by pressure in the axilla, if necessary under chloroform, and its fixation by an axillary pad or the Ω-shaped leather splint recommended by Erichsen, whilst the arm is kept to the side.

Fractures of the Upper End of the Humerus.—1. Of the **Anatomical Neck**, the so-called 'Intracapsular Fracture.' This is always due to blows or falls on the shoulder, never to indirect violence. It is evidenced by signs of a severe local trauma, with loss of mobility of the arm. The head of the humerus is found to be irregular in shape on examination from the axilla, and the fragment, if detached, may be distinctly felt. Crepitus is obtained on moving the arm, and there is some slight shortening, but not more than half an inch. In most cases the upper fragment is not totally detached, but remains connected with the rest of the bone by a few shreds of capsule, and thus necrosis is prevented. Should impaction occur, the small upper fragment is driven into the lower, and marked deformity of the head of the bone results. The acromion becomes unduly prominent, and the rounded projection of the deltoid is diminished, unless, as often happens, the swelling due to extravasation is considerable. Repair takes place mainly from the lower end, and, owing to the difficulty of apposing and immobilizing the fragments, a considerable mass of callus is usually formed. Examination must be conducted with great care lest impaction be disturbed, or any capsular attachments broken through. The usual **Treatment** recommended is to bind the arm to the side, and apply evaporating lotion for a few days if great ecchymosis exists. A pad or Ω-shaped splint is then placed in the axilla, and retained in position by a soft bandage or handkerchief passing over the top of the shoulder, and tied under the opposite axilla. This assists in raising the arm, which is also supported by an elbow-sling; finally, a comfortable poroplastic or leather cap is fitted over the shoulder and buckled on. Union generally occurs in about six weeks, but is often accompanied by a considerable formation of callus and great stiffness of the parts, for the removal of which massage, and even manipulation under chloroform, are required. To obviate these sequelæ, treatment by early massage and manipulation are now recommended by some surgeons, the limb being merely supported in a sling. The massage should commence about the third day (see p. 372).

2. Of the **Surgical Neck**, the 'Extracapsular Fracture.' The bone yields in this case below the muscles attached to the tuberosities, but above the insertions into the bicipital groove of the pectoralis major, latissimus dorsi, and teres major. It usually results from violence applied directly below the point of the shoulder, but also from falls on the hand or elbow. The fracture is, as a rule, transverse, and the displacement is a double one: the upper fragment is rotated outwards, and generally adducted by the muscles inserted into the tuberosities, especially the subscapularis; whilst the lower fragment is drawn inwards by those attached to the bicipital groove, and upwards by the deltoid, coraco-brachialis,

biceps, and triceps (Fig. 111). The appearance of the patient is sufficiently characteristic; the head of the bone is still in the glenoid cavity, so that there is no loss of the fulness of the shoulder, although there is a depression just below. The elbow is directed away from the side, and the axis of the lower fragment is upwards and inwards. A marked projection exists in front of the limb just below the clavicle, due to the presence of the upper end of the lower fragment in its new position close to the coracoid process. Crepitus can be readily obtained by extending and rotating the arm, which is shortened an inch or more. This fracture is often very painful from pressure of the upper end of the lower fragment against the brachial nerves. If impaction occurs, the signs are much less evident, and, indeed, may be very equivocal; the lower fragment is usually driven into the upper, and only slight shortening or displacement may be present.

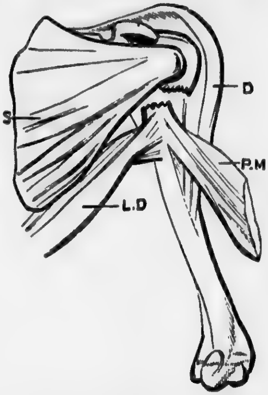

FIG. 111.—FRACTURE OF SURGICAL NECK OF HUMERUS.

S, Subscapularis; L D, latissimus dorsi; D, deltoid; P M, pectoralis major.

Complications.—The axillary vessels may be seriously damaged, or more commonly some of the nerves sustain injury, especially the circumflex, which winds round the neck of the bone close to the site of the fracture.

The **Treatment** is much the same as for the intracapsular variety, viz., the application of an axillary pad and a shoulder-cap, whilst the arm is kept to the side, and the hand only supported by a sling. The elbow should be allowed to hang to overcome the shortening. Union will usually result in four and a half to six weeks, with the formation of a good deal of callus. Massage may be used after a time; but an immoveable apparatus is necessary—at any rate, for two or three weeks—in order to obviate the displacement.

3. **Separation of the Upper Epiphysis** occurs up to the age of eighteen to twenty years, and includes the head and both the tuberosities. The line of separation is transverse, and the lower fragment is drawn inwards, projecting under the coracoid process, as in fracture of the surgical neck. The presence of the head of the bone in the glenoid cavity, and the smooth upper end of the lower portion, prevent it from being mistaken for a dislocation, whilst the softer crepitus and slighter degree of pain distinguish it from a fracture. The **Treatment** is the same as for a fracture.

4. The **Great Tuberosity** may occasionally be torn off as a result of direct or muscular violence, or as a complication of fracture

through the neck. If the whole tuberosity is separated, there is marked deformity, resulting in a great increase in the breadth of the shoulder. The fragment is displaced upwards and backwards by the unopposed action of the supra- and infra-spinatus, whilst the shaft of the humerus is drawn forwards and partially dislocated (or subluxated) by the subscapularis and other muscles. A distinct sulcus can be felt between the two bony masses, and if they can be brought together, crepitus is obtained. **Treatment.**—A pad is placed in the axilla, and the elbow kept to the side so as to throw the upper end of the bone outwards, whilst the tuberosity is drawn down to this as far as is possible by the pressure of a pad strapped on, the elbow being also supported by a sling. Another plan suggested is to elevate and extend the arm above the head, keeping it supported by pillows, till union has occurred—a most uncomfortable and tedious proceeding. A much more efficacious method, and one that need not be feared where asepsis is maintained, is to cut down on the fragment, and wire or peg it in position.

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Fractures of the Shaft of the Humerus may arise from any form of violence, whether direct or indirect, whilst it is the commonest site for fracture of the shaft of a long bone from muscular violence, as, *e.g.*, in throwing a cricket-ball. The signs of the injury are very obvious, and most typical. The displacement depends largely on the position of the fracture. If it occurs above the insertion of the deltoid, but below that of the muscles inserted into the bicipital groove, the upper fragment is drawn inwards, and the lower upwards and outwards. If, however, it is below the deltoid, the upper fragment is drawn outwards, and the lower upwards and inwards. As the line of fracture approaches the elbow, the displacement tends to become more antero-posterior than lateral, following the change in direction of the bone. The most common complication is injury to the musculo-spiral nerve which winds round the shaft close to its centre.

Treatment. — An internal angular splint reaching from the axilla to the wrist must be applied, together with three small lateral splints to fix the fragments, or a piece of Gooch or kettle-holder splint; the limb is kept to the side in a sling. Union is usually complete in five weeks.

It is not at all uncommon to meet with an ununited fracture of the shaft of this bone; this is probably due, not to any anatomical reasons, but simply to the fact that the necessity of fixing and supporting the elbow-joint has not been appreciated, the arm being allowed to hang loose on the false plea of tending to diminish the shortening.

Fractures of the Lower End of the Humerus.—In dealing with any injury in the vicinity of the elbow, it is absolutely essential that the relative position of the bony points, which can there be felt, should be accurately established, and a comparison made with those of the opposite side. Both arms should be stripped and examined in similar positions, a good plan being to place (if possible) both hands on the top of the head, so that the elbows look forwards. Normally four bony prominences can be made out, viz., the two condyles, the olecranon, and the head of the radius. The relation of the olecranon to the condyles varies with the position of the elbow. If the forearm is extended, the tip of the olecranon just touches the intercondyloid line, but is placed nearer the inner than the outer condyle, whilst in flexion of the forearm it lies below that line. The head of the radius in all positions of the arm is immediately below the outer condyle, and can be felt rotating beneath a dimple in the skin which appears at that spot. When the arm is flexed, the tip of the olecranon is a little in front of the posterior surface of the upper arm, so that a ruler placed along that surface misses the olecranon; this is a useful guide in ascertaining if the bones of the forearm have been displaced backwards or forwards.

1. **Transverse Supracondyloid Fracture**, involving the shaft about 1 or 2 inches above the joint, is due either to a fall on the hand with the arm bent, when the lower fragment is usually displaced backwards, or sometimes to a fall on or violence directed to the point of the elbow, when the displacement is either forwards or backwards. The accident is very common in children, then taking the form of a separation of the lower epiphysis. When the lower fragment is displaced backwards, it is also drawn up by the action of the triceps upon the olecranon, a certain amount of angular as well as vertical deformity being thus produced; when displaced forwards, apparent lengthening of the forearm results, with a loss of prominence of the olecranon. The former of these conditions is likely to be mistaken for a dislocation of both bones backwards at the elbow (*cf.* Fig. 112, A and B), but may be recognised by the following facts: (*a*) The relative position of the bony points at the elbow is unimpaired; in a dislocation they are necessarily disturbed. (*b*) The upper arm measured from a tubercle which can be easily felt at the back of the acromion to the outer condyle is shortened in a fracture, but remains the same length in a dislocation. (*c*) The projection of the upper fragment forwards is felt beneath the skin above the crease of the joint, whilst in a dislocation it corresponds with it. (*d*) The deformity is easily reduced with crepitus, but readily reappears; in a dislocation the bones are replaced with difficulty, but once replaced they usually remain in position. It is most important to recognise this condition at once, although it may be difficult, owing to the amount of swelling and ecchymosis present; the application of a cooling lotion for a few days will so reduce this as to permit a thorough examination, and this is most essential, as a wrong diagnosis probably leads to bad treatment, and much subsequent impairment of function of the limb. Skiagraphy will at once determine the nature of the lesion.

Much care is needed in the **Treatment** of these cases in order to prevent ankylosis, and the stereotyped application of an internal angular splint is by no means sufficient. To correct the backward deformity the elbow must be flexed, and extension made upon the forearm, which is placed in a position midway between pronation and supination. It may then suffice to apply an anterior angular splint in the bend of the elbow, and a straight posterior splint reaching below the tip of the olecranon, so as to keep it well forwards; or the same effect may be produced if the arrangement of splints is reversed. If there is any difficulty in retaining the bones in position, a pad may be placed over the lower end of the upper fragment in front, and another over the tip of the olecranon behind, and a figure-of-8 bandage over them will efficiently press the latter process of bone downwards and forwards; splints are then applied as indicated above. In these fractures the elbow-joint is not as a rule involved, and therefore passive movement should not be commenced too early, for fear of deformity owing to yielding of the callus. In displacements of the bone forwards an anterior angular splint should be employed, and possibly a short posterior one in addition.

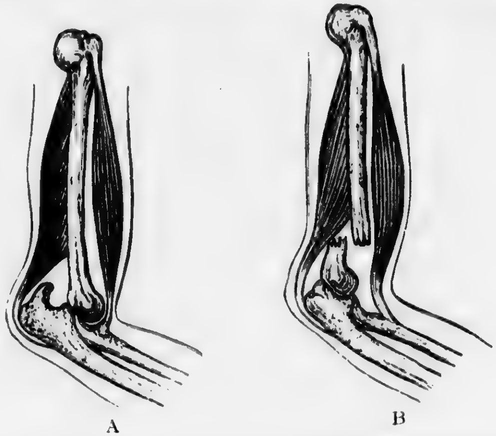


FIG. 112.—FRACTURE OF LOWER END OF HUMERUS COMPARED WITH DISLOCATION OF RADIUS AND ULNA BACKWARDS AT ELBOW. (TILLMANNS.)

2. The **Condyles** have been broken off both by direct and indirect violence, though more commonly by the former. This particularly applies to the inner condyle, since the outer is sometimes broken by indirect violence, such as a fall on the hand, owing to the laxity of the elbow-joint on this side allowing considerable mobility between the radial head and the capitellum of the humerus. Fracture of the **external condyle** always involves the elbow-joint, and is more

common than that of the inner. The line of fracture runs from the condylar ridge downwards and inwards so as to separate the capitellum, or may even encroach upon the trochlear surface. The fragment is but little displaced, and can be felt to move on the rest of the bone with crepitus, which may also be produced by rotation of the hand and radius. The accident is associated with much pain and ecchymosis. Fracture of the **internal condyle** may be intra- or extra-capsular. The *extra-articular* variety (Fig. 113) consists of a mere displacement of the tip of the condyle (or epicondyle), possibly of the nature of a separation of the epiphysis, since it occurs mainly in children. The small fragment is drawn a little downwards by the muscles attached to it (Fig. 113A), and the fracture is readily detected by the usual signs; it may be associated with injury of the ulnar nerve. The *intra-articular* form is the more common, and extends from the condylar ridge to the trochlear surface, implicating the coronoid and olecranon fossæ. The fragment is displaced a little upwards and backwards, the ulna usually accompanying it, so that on extending the elbow the olecranon appears unduly prominent, the lower end of the humerus projects anteriorly, and the forearm is slightly adducted inwards. The ulnar nerve may also be injured in this case.

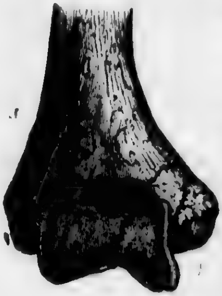


FIG. 113.—FRACTURES OF INTERNAL CONDYLE AND EPICONDYLE OF HUMERUS. (TILLMANNS.)

Treatment.—Flex the forearm and place it on an angular splint, using a pad and strapping to maintain the fragments in position. If the joint has been involved, there is a great tendency to impairment of its usefulness, and passive movement should be started early. Possibly in these cases it would be wiser to apply no splints, and treat the fracture by early massage (p. 372).

3. **T- or Y-shaped Fracture** of the lower end of the humerus occurs usually as the result of direct injury. A fissure extends into the joint between the condyles, and may either bifurcate to either side in a Y-shaped manner, detaching partially or completely the two condyles, or it may be connected with a transverse supracondyloid fissure, constituting the T-shaped form. If the fragments are not totally detached, there will be much bruising and pain, but no crepitus; but if the fragments are separated, the condyles will move on each other with crepitus, and the elbow will be widened with much deformity. In these cases the joint is very likely to become stiff, owing not only to adhesions forming within it, but also to the filling up of the fossæ in the lower end of the humerus with callus. Excess of violence may lead to comminution, and luxation of the bones of the forearm may also occur. A marked feature of these cases is the rapidity with which swell-

ing supervenes, owing to hæmorrhage into and around the joint, rendering accurate diagnosis difficult. **Treatment** must be directed towards reducing the swelling, and then, after manipulating the fragments into as good a position as possible, an internal angular splint is applied, and passive motion started early. Possibly an antiseptic incision and wiring or pegging of the fragments would give better results, or even in some cases excision of the ends of the bones may be required.

FIG. 113A.—SKIAGRAM OF FRACTURE OF INTERNAL EPICONDYLE OF HUMERUS.

Fractures of the Ulna.—1. The **Olecranon** is frequently broken, usually by direct violence, the patient falling on the bent elbow, but occasionally by muscular action. The displacement is often very considerable, the fragment being drawn up by the triceps; but if the ligamentous fibres extending from the tendon to the fascia of the forearm remain intact, there may be but little separation. When complete, the bones of the forearm are displaced forwards, and almost dislocated. The line of fracture usually runs through the base of the process at its attachment to the shaft, and is for the most part transverse. Great swelling in and around the joint comes on very early; on examination, the detached fragment can be readily distinguished, and between it and the shaft a sulcus, which increases on flexion and diminishes on extending the forearm. The nature of the union depends on the amount of separation of the fragments, and the treatment adopted. If the fragments are not brought accurately into apposition, fibrous union is likely to occur, and although the new cicatricial tissue may stretch considerably, a useful elbow may sometimes result; if, however, the fragments are brought in contact, bony union usually occurs, though even then some impairment of function may occasionally follow owing to callus encroaching on the articular surface, which is always involved. When due to direct violence, the fracture may either be compound or comminuted, and injury to the ulnar nerve is likely to result.

Treatment.—The most satisfactory plan to adopt is to lay the parts freely open, to thoroughly clear the joint of all blood and exudation, remove shreds of tendon and ligaments which may be placed between the fragments, and then wire them together, the wire just extending down to the articular cartilage. The same precautions and after-treatment must be followed as in dealing with the patella (p. 420). A similar plan should be adopted in all compound cases, and in those where loose fibrous union has occurred with a resulting weak and relaxed elbow; in the latter instance the new fibrous tissue must be entirely dissected away and the bony surfaces thoroughly freshened. If an operation is not undertaken, the arm should be put up on a straight anterior splint, the fragment being drawn into position as well as possible by means of a pad and figure-of-8 bandage. Union will be attained in four or five weeks, and passive movement should then be commenced.

2. The **Coronoid Process** is so deeply placed and so well protected that fractures must necessarily be very uncommon. Much discussion has been raised as to whether or not it is a usual accompaniment of a dislocation of both bones backwards, the only condition under which fracture is known to occur; but the consensus of opinion, though admitting its occasional occurrence, is opposed to it being at all frequent. The fragment is drawn upwards by the brachialis anticus, but is so small as to be detected with difficulty. The signs relied on in making a diagnosis of such a condition are that reduction of a backward dislocation of the elbow is easier than usual and accompanied by crepitus, and that the deformity is likely to recur. The **Treatment** consists in apposing the bony surfaces, if possible, by flexing the forearm. Bony union is, however, less important than a freely moveable elbow, and therefore passive movement is commenced early.

3. The **Shaft of the Ulna** may be fractured by itself as a result of direct violence, to which its exposed position renders it peculiarly

liable. Fracture is also said to occur as a complication of several of the forms of dislocation of the radius alone. The superficial position of the posterior border renders examination of the bone easy; if displacement or a breach of substance occurs, it is readily detected, but when merely a fissure exists, it is not so easy to make out. The constant pain referred to one spot, the slight mobility, and possible crepitus, indicate the character of the lesion. No longitudinal displacement can occur if the radius remains intact, and under such circumstances the only possible deformity consists in a slight drawing forward of the upper fragment by the brachialis anticus, whilst the lower fragment is approximated to the radius by the pronator quadratus.

Treatment.—The arm is placed midway between pronation and supination, the deformity corrected, and the limb kept at rest between anterior and posterior splints.

4. The **Styloid Process** may be detached by direct violence, or more rarely as a complication of fracture of the lower end of the radius. The displacement may be considerable and very evident, being governed by the direction of the violence. Treatment consists in replacing the fragment by manipulation, and fixing it by adhesive plaster; an anterior splint is applied, and the arm kept in a sling.

Fractures of the Radius.—1. The **Head of the Radius** is rarely broken alone, such an accident being usually associated with other injuries to the elbow, as, for instance, fracture of the outer humeral condyle or some form of dislocation. The upper epiphysis may be separated, or there may be merely a transverse or vertical fissure; but under any circumstances the displacement is slight if the orbicular ligament remains intact. In complete separation the head remains immoveable, and crepitus is produced when the arm is rotated; bony union usually follows with more or less impairment of function, but sometimes the head, or a portion of it, remains detached as a loose body in the joint. All that is needed, as a rule, is the application of a splint, the limb being kept midway between pronation and supination, and early passive movement instituted. Excision of the head may be required for comminution, or owing to fixation of the joint by excessive formation of callus.

2. The **Neck**, *i.e.*, the portion between the orbicular ligament and the biceps tuberosity, is occasionally broken. The lower fragment is drawn upwards and forwards by the biceps, causing a bony projection on the front of the elbow, especially evident on attempting to flex the joint, whilst the forearm is pronated with loss of the power of rotation, and the head of the bone does not accompany the shaft on passively rotating it.

Treatment.—The arm is flexed to relax the biceps, and the limb placed on a posterior angular splint, with a pad over the front of the lower fragment, if it project unduly. Passive movement should not be commenced too early, as the lesion is extra-articular, and the biceps may produce permanent deformity if allowed to act upon unconsolidated callus.

3. The **Shaft** of the radius is broken either by direct violence, or by falls on the palm; the latter accident, however, rarely causes fracture except at the lower end. The signs are sufficiently evident, owing to the superficial position of the bone, consisting of localized pain, loss of power of active rotation, whilst passive rotary movements are accompanied by crepitus, the head of the bone and upper fragment remaining immobile below the outer condyle unless impaction is present.

The *displacement* is somewhat characteristic. If the fracture is situated *above the insertion of the pronator teres*, the upper fragment is flexed and fully supinated by the action of the biceps and supinator brevis, whilst the lower fragment is drawn towards the ulna and fully pronated by the unopposed action of the two pronator muscles. Ordinary **Treatment**, *i.e.*, with the arm midway between pronation and supination, would in such a case produce most unsatisfactory results, and inasmuch as it is practically impossible to command the small upper fragment, the lower must be brought into apposition with it by fully supinating the forearm and hand after fully flexing the elbow, and applying a posterior splint, the patient being preferably kept in bed for a time and the arm laid on pillows. It may afterwards be supported in a hollow leather splint carried across the body, and with the palm directed upwards.

When the fracture is placed *below the insertion of the pronator teres*, the upper fragment is drawn forwards by the action of the biceps, and inwards by the pronator, assuming a position midway between pronation and supination; the lower fragment is approximated to the ulna partly by the direct action of the pronator quadratus, partly by the supinator longus tilting the upper end inwards; the hand is fully pronated looking downwards. Union to the ulna by callus thrown across the interosseous space is not unlikely to occur. **Treatment** by anterior and posterior splints may here be adopted, with a good interosseous pad interposed between the limb and the splints, the arm being placed midway between pronation and supination.

4. The **Lower End of the Radius** is broken with extreme frequency, constituting what is known as **Colles's Fracture**. This injury occurs most commonly in women of advanced years, although it may happen at any age or to either sex. It is almost invariably due to falls upon the outstretched palm, when the hand is completely pronated and extended. The line of fracture is placed about 1 inch from the wrist, though rather under than over this. It is by no means purely transverse, being usually oblique in an antero-posterior direction, sloping from above downwards and forwards, so that the fracture is nearer the wrist-joint in front than it is behind, and also not uncommonly oblique laterally, slanting from without downwards and inwards.

The *displacement* is a somewhat complicated one. (*a*) The lower fragment is carried backwards and a little upwards, a condition resulting from the direction of the violence, viz., a fall on the palm of the outstretched hand, the radius being thus compressed between the ground and the weight of the body, and yielding at what is evidently a weak spot; this deformity is maintained by the action of the radial extensor muscles of the wrist, and often by impaction of the fragments. (*b*) From the fact that the main violence is received by the ball of the thumb, owing to the extreme pronation of the hand, the outer side of the lower fragment is displaced more than the inner, which, moreover, remains fixed to the ulna by the strong inferior radio-ulnar ligaments. This position is in part kept up by the tension of the extensors of the thumb and the supinator longus, but mainly by impaction of the fragments. The hand and carpus always follow the lower fragment, and hence the former becomes markedly abducted, causing the styloid process of the ulna to become unduly prominent, and lower than that of the radius, whereas it is normally placed on a slightly higher level. (*c*) The lower fragment is also rotated around a transverse axis, so that the lower articular surface looks backwards as well as downwards, a displacement due to the fact that in falling the force is directed, through the carpus, more to the posterior than to the anterior aspect of the bone. (*d*) The upper fragment is pronated and approximated to the ulna by the pronator quadratus muscle. The *deformity* produced by the fracture is therefore a very characteristic one. The hand is in a position of radial abduction, and usually pronated, with the fingers somewhat flexed. Three abnormal osseous projections are present: (i.) The styloid process of the ulna is very marked, owing to the radial abduction of the hand (Fig. 115); (ii.) on the back of the wrist is a prominence which terminates abruptly above, caused by the projection of the lower fragment (Fig. 114); and (iii.) corresponding to this dorsal projection there is a well-marked depression on the palmar surface, and above it a less sharply-defined swelling, which gradually shelves into the forearm, due to the upper fragment. Pronation and supination are lost, and, as a rule, there is neither crepitus nor preternatural mobility, owing to impaction; but after forcible extension of the hand this may be readily obtained. In doubtful cases help in diagnosis may be obtained by observing

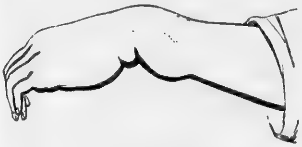


FIG. 114.—COLLES'S FRACTURE: LATERAL VIEW.

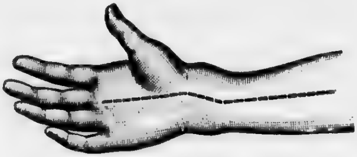


FIG. 115.—COLLES'S FRACTURE: PALMAR VIEW. (TILLMANNS.)

the relative position of the two styloid processes; as a rule, that of the radius is well below that of the ulna, but in cases of fracture the ulnar projection is well below that of the radius. The value of the Röntgen rays in establishing a diagnosis has also been alluded to above (p. 361).

As already stated, the fracture is commonly an impacted one, the upper fragment being firmly driven into the cancellous tissue of the lower end; excess of violence may, however, disimpact, but often at the expense of comminution of the lower fragment. Union is usually effected without difficulty, but the patient should always be warned at an early date to expect some considerable impairment in the subsequent mobility of the fingers and hand, as well as deformity about the wrist. Of course this is more marked in unreduced impacted fractures; but it is often a question whether in old people it is not better practice to leave the fracture impacted, rather than cause the pain necessarily arising from disengaging the fragments, a process which might be followed by inflammation of the joint.

Treatment.—To reduce the deformity and set the fracture, extension and manipulation are both needed. The patient should be seated on a chair, and the surgeon, standing in front, should grasp the hand firmly, using the right hand for fractures on the right side, and the left for those on that side. Counter-extension is made from the flexed elbow, and the hand is then forcibly extended and adducted; disimpaction is thus brought about, and a little manipulation will enable the fragments to be moulded into position.

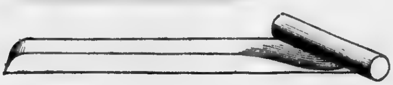


FIG. 116.—CARR'S SPLINT FOR COLLES'S FRACTURE. (DOWN BROTHERS.)

Many plans have been adopted in the application of splints for this fracture: (1) A piece of *Gooch splint* is perhaps the most simple and efficacious. It is shaped so as to cover the radius front and back as far as the middle line of the arm, and extends nearly from the elbow to the front and back of the knuckles of the index and middle fingers; its lower end is hollowed out in a horseshoe manner, so as not to reach beyond the end of the metacarpal bone of the thumb. This is well padded and firmly bandaged on; it grasps the radius and steadies the hand in a position of adduction, without in any way interfering with the movements of the fingers. (2) *Carr's splint* (Fig. 116) is a very similar contrivance, consisting of two shaped pieces of wood fitting the front and back of the radial side of the lower forearm, whilst to the palmar one is attached an oblique rod to be grasped by the fingers, and thus the hand and wrist are maintained in a position of adduction, whilst the fingers can be freely moved. (3) The *Pistol splint* consists of a straight portion fitted to the front of the forearm, whilst the handpiece is bent at an angle like the butt-end of a pistol. It may also be applied to the back of the forearm, together with a short straight splint on the palmar aspect reaching to the wrist. It keeps the hand and arm in excellent position, but is objectionable because the fingers are also restrained. If, however, it is shortened at the end of five or seven days so as not to extend beyond the knuckles, it may be used without doing harm. (4) *Gordon's apparatus* is a somewhat more elaborate appliance, which has no special advantages; for a description we must refer to larger text-books. (5) Two straight splints may be applied to the front and back of the forearm, which is kept midway between pronation and supination; neither of them should extend beyond the knuckles, so that the fingers are entirely free. The weight of the hand, when the arm is slung, keeps it in a position of adduction.

Union is usually sufficiently firm in four or five weeks to allow the removal of the splints, the arm being kept in a leather or gutta-percha support for some time longer, and massage and passive movement freely employed. The fingers should, however, be moved during the first week.

This is another of the fractures for which the new plan of treatment by early massage is specially indicated. When once reposition has been effected, there is but little tendency for the displacement to recur. Massage may be commenced on about the third day, and all the apparatus required is a hollow leather splint, supported by a sling round the neck, the hand being allowed to hang in a position of adduction.

5. **Separation of the Lower Epiphysis** of the radius occurs sometimes in young people under twenty, and simulates somewhat closely a Colles's fracture owing to the dorsal displacement of the lower fragment. The lower end of the diaphysis projects anteriorly to a much greater extent, and, indeed, may protrude through the skin of the wrist, causing the fracture to become compound. The lower end of the ulna may also be involved in the accident, either the epiphysis being separated, or the shaft broken a little above. A backward dislocation of the wrist is then somewhat closely simulated, but a diagnosis can be readily made by observing the relative position of the styloid process to the carpal bones. **Treatment** is practically the same as for Colles's fracture.

Fracture of both Bones of the Forearm may result from direct or indirect violence, but more commonly from the former. Any part of the bones may yield, but the middle or lower thirds are most frequently affected, owing to their greater exposure. The line of fracture may be transverse or oblique, and the displacement varies both with this and with the force employed. Occasionally both bones are broken close to the wrist by a fall on the palm of the hand. Such really consists in a Colles's fracture, complicated by the head and styloid process of the ulna being also detached ; investigations with the Röntgen rays tend to show that this type of fracture is much more common than was formerly anticipated. The upper fragments are drawn together and pronated, whilst the lower end of the radius is drawn up by the supinator longus. The diagnosis of these fractures is very simple, since there is, as a rule, obvious deformity. **Treatment** consists in reduction by extension conjoined with manipulation, and the application of splints which will prevent cross-union of the bones. If the fracture is above the insertion of the pronator teres, the arm must be put up in full supination, as suggested for a similar fracture of the radius alone (p. 398), whilst below that spot the usual position midway between pronation and supination may be allowed. Union is generally complete in five or six weeks.

Fractures of the Metacarpal Bones and Phalanges are not uncommon, being due to direct violence, and hence usually transverse in direction. There is but little displacement except when a metacarpal bone is broken close to its head, when the latter portion may be carried forwards into the palm, and thus simulate a dislocation. The other signs are obvious, and all the treatment required is immobilization for a short time. For the phalanges a small zinc splint may be moulded along the front of the finger.

Fractures of the Pelvis.

Fractures of the pelvic bones are almost always the result of direct injury, such as blows, gunshot wounds, and railway, carriage, or cart accidents. For convenience they may be described under the following headings :

1. **Fractures of the False Pelvis.**—A portion of the crista ilii may be broken off, or the anterior or posterior spines separated, or merely a fissure in the bone produced. But little importance attaches to such conditions, as the displacement can never be great. A portion of the crest may be drawn down by the glutei muscles, or the anterior superior spine displaced by the sartorius; but in severer cases, when the bones are crushed and comminuted, the true pelvis is likely to be also affected, and most serious consequences may arise. Considerable pain is always produced by these conditions, especially on any vigorous respiratory movements. Union occurs readily, all the treatment required being to keep the patient quiet in bed with the shoulders raised, and the legs supported to relax the muscles. A flannel bandage round the pelvis gives comfort and support.

2. **Fracture of the True Pelvis** is a much more serious accident. The line of fracture usually runs into the obturator foramen, and

may detach both the horizontal ramus of the pubes and the ascending ramus of the ischium from the rest of the innominate bone (Fig. 117). This is frequently conjoined with a fracture through the sacro-iliac synchondrosis either on the same or opposite side, but more frequently the latter; whilst a double fracture, front and back, may also occur at these, the weakest points. The cause of the posterior fracture is that, when the pelvic ring has yielded anteriorly from the violence, the continued strain, whether directed from the front or from the sides, must necessarily fall on the part where the ilium is most closely connected with the sacrum, and the bones then give way rather than the unyielding and powerful sacro-iliac ligaments. The **Symptoms** are those of shock and pain in and around the pelvis, especially on movements of the legs or on coughing. There may be local ecchymosis, and tenderness over the pubic ramus, and the patient either cannot stand, or feels as if he were falling to pieces on attempting to do so. There is rarely any deformity, although occasionally such an occurrence is noted. Crepitus may be elicited on grasping the iliac bones, and moving them one on the other; but such an investigation must be very sparingly indulged in. Complications from injury to the internal viscera are frequently met with, especially of the bladder, rectum, urethra, or vagina, as indicated by hæmorrhage into or from these organs. An aseptic catheter should, if possible, be passed as a routine proceeding, and if the urine is blood-stained, it is tied in.

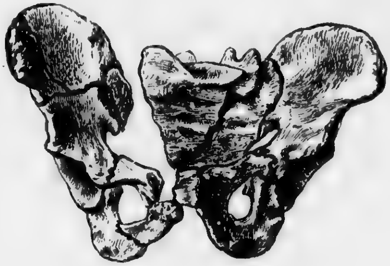


FIG. 117.—FRACTURE OF THE PELVIS. (BRYANT.)

Treatment.—The patient should be moved with the greatest care, for fear of producing or increasing visceral complications. He is put to bed, and any obvious displaced fragments reduced, if practicable, possibly under an anæsthetic. A broad flannel bandage should be applied, the knees tied together, and a leather or poroplastic splint moulded to the pelvis. Visceral complications must receive attention, as indicated elsewhere. Union may be expected in about six weeks, but the patient should be kept in bed for at least eight, and even then only allowed to get about on crutches, wearing a padded belt.

3. **Fracture of the Acetabulum** is of two types: either the posterior lip is broken off as a result of violence directed against it by the head of the femur, which is dislocated backwards by the

same accident, or a fall on the trochanter may cause a simple fissure extending right across the cavity, or may resolve it into its three constituent elements, or may even drive the head of the bone right through into the pelvic cavity. In the former case, the limb is in the position of a dorsal dislocation; this can be reduced without difficulty, and possibly with crepitus, but manifests a great tendency to recur. Prolonged extension with a long splint is needed in such cases. In the latter class of injury a mere fissure of the acetabulum produces but few symptoms beyond a little pain and impairment of movement; but if the head of the bone is driven into the pelvic cavity, the symptoms are much more serious, on account of the associated injuries to the viscera and the greater amount of violence employed. The case will resemble one of fracture of the neck of the femur, but there is usually only very slight mobility, and the head of the bone may be felt within the pelvis on rectal examination. An attempt should be made to free the head of the bone, and the case treated as one of fracture of the neck of the femur; but a fatal issue is very likely to follow.

4. **Fracture of the Tuber Ischii** may occur as a result of falls in the sitting position. The diagnosis is obscure, but crepitus may possibly be felt.

5. **Fractures of the Sacrum** are always due to direct violence of considerable severity, such as kicks, blows, or gunshot wounds. It is not unfrequently comminuted, and, from the associated injury to the lower sacral nerves, may result in loss of power of the bladder and rectum. In a transverse fracture, the lower fragment is usually displaced forwards, and may cause pressure upon the rectum; irregularity in the shape of the bone may be detected from within (per rectum) or from without.

Treatment.—The lower fragment should be replaced, if possible; but considerable difficulty may be experienced in keeping it in position. Hamilton recommends enforced constipation, so as to produce a 'fæcal splint'! A well-fitting pelvic band, with rest in bed, is probably all that is necessary.

6. **Fractures of the Coccyx** are by no means uncommon as a result of falls or blows, although its mobility often protects it from injury. Great pain is felt on walking, or on any movement which increases the intra-abdominal pressure, such as straining, coughing, defæcation, etc., since the coccygeus muscle which is attached to this bone forms part of the lower diaphragm of the abdomen. A rectal examination reveals the preternatural mobility of the lower fragment, angular deformity, and perhaps crepitus. The **Treatment** consists in keeping the patient at rest until union has occurred; it is impossible to apply any apparatus to correct the deformity. Sometimes the bone unites at an angle, causing much pain and discomfort, whilst difficulty in parturition may arise from this cause. *Excision of the bone* is then required. The

patient lies on the abdomen with the legs slightly flexed, and a longitudinal incision is made in the middle line. The apex and lateral margins of the bone are cleared, and the ligamentous tissues uniting it to the sacrum divided by the knife; the bone is now laid hold of by sequestrum forceps, and its remaining attachments severed, due precautions being taken not to encroach on the rectum. Two or three stitches are inserted, and also a drainage-tube for a few hours; the dressing is secured in position by a T-bandage, but it is not common to obtain healing by first intention. The bowels should be confined for some days after the operation.

Falls upon the coccyx, unaccompanied by fracture, sometimes give rise to a most severe and intractable type of neuralgia, known as **coccydynia**, which may quite prevent the patient from following his avocations. If all the usual sedatives fail in giving relief, the bone must be excised.

Fractures of the Upper End of the Femur.

1. **Fractures of the Neck of the Femur** are commonly divided into intra- and extra-capsular varieties, and, although this is by no means free from objections, yet it constitutes a useful working basis.

The **Intracapsular Fracture** (Fig. 118) is met with in persons in advanced life, and especially in females, only about 1 per cent. of the cases occurring in individuals under fifty. This is explained by the atrophic changes which take place in the cervix femoris of elderly people. The spaces between the bony cancelli are enlarged, and loaded with soft fat, whilst the ensheathing compact tissue is thinned, and the 'calcar femorale' of Merkel (*i.e.*, the process of thick cortical substance running from the lesser trochanter to the under part of the head) is atrophied. The neck of the bone is sometimes more horizontal than usual, and the head sinks below its usual position. Under such circumstances, it requires but little violence to produce a fracture, the direction of which varies according to the force applied. As a rule, the accident is due to some slight stumble or fall, such as slipping off the kerb or tripping upstairs; the bone yields in consequence, and the patient falls to the ground. The line of fracture may be transverse or oblique, and is mainly intracapsular. Some of the fibres reflected from the under surface of the capsule to the head of the bone may remain untorn at first, but later on they give way from inflammatory softening or injudicious manipulation or attempts to use the limb. The

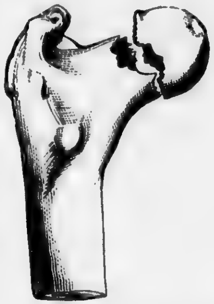


FIG. 118.—INTRACAPSULAR FRACTURE OF THE CERVIX FEMORIS.

fracture is not usually impacted; if, however, this condition should occur, the upper end of the shaft is driven into the loose cancellous tissue of the head. The *displacement* is necessarily limited entirely to the lower fragment, which is drawn upwards by the glutei, recti, and hamstring muscles, and rotated outwards and somewhat backwards, so that the fractured surface looks almost directly forwards.

The *Method of Union* in these cases depends to a large extent upon the general condition of the individual. If of a healthy temperament, and without any chronic pulmonary affection, so that he can be kept in the recumbent posture for six or eight weeks, bony union may certainly occur. The main process of repair takes place from the lower end, as evidenced by the fact that no callus is formed from the head of the bone, the vascular supply being only just sufficient to maintain its vitality. If, however, the patient is feeble and weakly, and especially if the subject of chronic bronchitis and emphysema, the prognosis is by no means good, since hypostatic pneumonia and extensive bedsores may carry him off during the short stay in bed, which is always necessary, in order to relieve the more urgent symptoms of pain. Bony union is never, under these circumstances, to be expected, and a loose fibrous union, or even a false joint, is the best that can be looked for, the patient henceforth walking with the assistance of a stick or crutch.

Extracapsular Fracture of the cervix femoris (Fig. 119) is an absolute misnomer, since the capsule extends to the shaft of the bone along the anterior intertrochanteric line, and leaves no portion of the neck uncovered in this situation. The line of fracture is placed in front, either along the attachment of the capsule or within it, and is really only extracapsular behind; sometimes, moreover, the shaft itself is considerably encroached on. The great trochanter is often involved in the fracture being splintered or detached, and the lesser trochanter may be split off with a portion of the shaft, so that the bone is broken into at least three different fragments.

Mechanism.—This fracture is usually the result of direct violence acting transversely upon the trochanter major, as from a heavy fall upon the hip. The posterior part of the neck, being weaker than the anterior, first gives way, being more or less crushed and comminuted; the whole neck then yields, and the severed head and neck are forcibly impacted into the junction of the trochanter and shaft (Fig. 119, B). The majority of these cases are thus primarily impacted, continuation of the violence producing disimpaction, coupled either with detachment of one or both trochanters, or with comminution of the great trochanter. A similar result may follow at a later date from the inflammatory exudation causing the impacted parts to be separated, or from injudicious manipulation.

The *displacement* is much the same as in the former variety; the upper fragment remains *in statu quo*, whilst the lower is drawn up and everted, only to a greater extent. Shortening may at first be slight, but is likely to increase at the end of a few days, as a result of disimpaction of the fragments, or from the yielding of the reflected fibres of the capsule, or from the tonic action of the muscles. Later on, moreover, the shortening may again increase from a rapid absorption of the neck, which occasionally follows this accident, or is possibly due to the supervention of osteo-arthritis.

The **Signs and Symptoms** of these two fractures may well be considered together, the points of similarity and contrast being in this way more effectually emphasized.

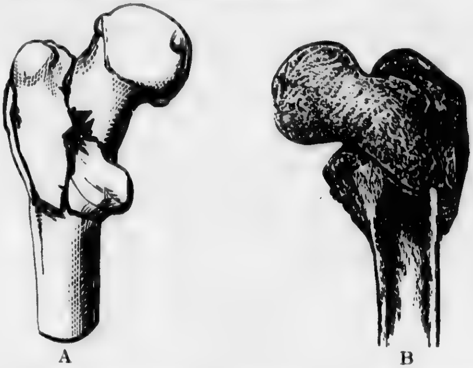


FIG. 119.—EXTRACAPSULAR FRACTURE OF CERVIX FEMORIS.

A, From behind, showing detachment of both trochanters; B, on section, showing impaction of head and neck into base of trochanter, which also is detached.

(*a*) The signs of *local trauma*, viz., pain, bruising, and swelling, may be present in both; but whilst very slight in the intracapsular variety, they are very marked in the extracapsular. It must not be overlooked, however, that even in the former the patient may fall on the affected hip after the fracture has occurred, and thus cause a considerable amount of bruising.

(*b*) *Crepitus* is evident in the unimpacted forms of each; but it is unnecessary and, indeed, unwise to elicit it by forcible manipulation, especially in the intracapsular variety.

(*c*) *Loss of power* of the limb exists to a variable extent, and is perhaps more marked in the extracapsular form than in the intracapsular. Cases of the latter in which the patient was able to walk into hospital some days after the accident are not unknown, and are probably due to impaction.

(*d*) *Eversion* is a most characteristic feature in both varieties, the limb as a rule lying absolutely helpless on its outer side. This displacement is accredited to the natural weight of the limb, to the greater fragility of the back of the cervix, causing it to be more comminuted than the anterior surface, and, lastly, to the greater power of the external rotator muscles. *Inversion* has been met with in a few rare cases, but is probably due to the violence in the particular instance being directed from behind forwards, and to impaction of the fragments.

(*e*) *Shortening* is slight in the early stage of intracapsular, and much greater in the extracapsular, fractures. In the latter case the shortening usually attains its maximum—viz., 1½ to 2½, or even 3 inches—at once; but such is not the case in the former. It is indicated by displacement of the trochanter upwards, due allowance being made for the position of the limb as regards abduction or adduction.

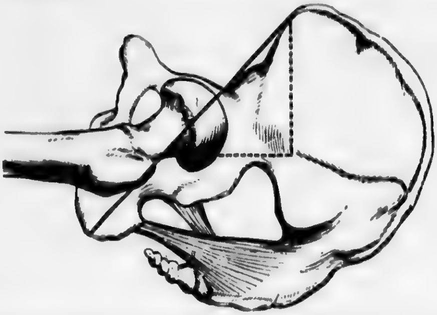


FIG. 120.—NÉLATON'S LINE AND BRYANT'S MEASUREMENT FOR ASCERTAINING POSITION OF GREAT TROCHANTER.

(*f*) The *position of the great trochanter* is of the greatest importance. It is raised above its ordinary position and everted; it is approximated to the middle line of the body and to the anterior superior iliac spine, and rotates in the arc of a smaller circle than usual, the radius being the thickness of the trochanter alone, instead of including also the length of the neck. The demonstration of this position is most important, and, amongst others, the following tests are employed:

Nélaton's test (Fig. 120) consists of a line drawn from the anterior superior spine to the most prominent point of the tuber ischii. The centre of this corresponds to the top of the great trochanter, if the limb is placed in the axis of the body; but if either abduction or adduction is present, the top is situated slightly above or below the line. Definite elevation of the bone above the line indicates shortening of the limb due to dislocation backwards, fracture of the neck, or absorption of the neck from disease.

Bryant's Test Line (Fig. 120).—In this the patient lies in a recumbent posture, and a vertical line is let fall from the anterior superior spine. The perpendicular distance of the top of the great trochanter from the line is compared with a similar measurement on the opposite side; definite shortening may thus be discovered.

Morris's bitrochanteric test indicates the amount of inward displacement. It is conducted by measuring the distance between the outer surfaces of the trochanters and the middle line of the body by means of a rod graduated from the centre, along which two pointers work outwards. Shortening in this direction will also be observed in most dislocations of the hip-joint.

One other change in the great trochanter may be noted in the extracapsular form of fracture, which can be utilized as a useful diagnostic feature between it and the intracapsular variety, viz., the great amount of *thickening* of the process which is always produced, owing to the excessive development of callus. In the intracapsular variety it is rarely fissured or injured, and therefore no thickening occurs.

(*g*) Lastly, *relaxation of the fascia* between the crest of the ilium and the great trochanter (that is, the upper part of the ilio-tibial band) is given as a characteristic feature of these fractures.

Diagnosis.—Simple *unimpacted* fractures are readily detected, and there can be but little difficulty in distinguishing the two forms, either from one another or from other injuries. The fact that an *impacted* fracture has occurred can also be easily made out as a rule, the pain, eversion, and shortening sufficing to indicate its existence; but it is often very difficult to say which of the two forms of fracture is present, especially if the surgeon is not called till late in the case. The character of the accident and the age of the patient must be taken into account, whilst the existence of fissuring or thickening of the trochanter, or the excessive amount of shortening, may indicate that the lesion has been extracapsular. From a *severe contusion* of the hip, which may be associated with marked eversion, a fracture is known by the absence of shortening and crepitus; there is no displacement of the trochanter, which rotates in a normal manner. The shortening which follows, owing to subsequent atrophy of the neck, may, however, complicate matters. In *dislocations* the head of the bone can be felt in an abnormal position, and hence no difficulty should be experienced in this direction. In *chronic osteo-arthritis* of the hip with antecedent shortening and marked bony crepitus, there may be no history of accident, and no acute eversion, pain, or loss of power; possibly the existence of similar disease in other joints may assist the surgeon, whilst osteo-arthritis of the hip usually results in prominence of the trochanter, and not in flattening, as occurs after fracture. Moreover, the fascia above the trochanter is never relaxed in osteo-arthritis, always in fractures. It must not be forgotten that, after an intracapsular fracture, the patient may fall, not on the injured side, but on the sound thigh, and cases have even been known where all the attention of the surgeon was being directed to the wrong limb owing to the amount of bruising there manifested.

The **Treatment** of intracapsular fractures must depend in great measure, as already stated, upon the individual.

If old, weakly, and with a tendency to chronic bronchitis, long confinement to bed would have a most deleterious, if not fatal, effect. In such cases the limb is put at rest for a few days between sandbags, and cooling lotions applied. A Thomas's splint should be fitted as early as possible, and the patient encouraged to get about on crutches.

In a healthy individual with good physique, bony union should be attempted by keeping the patient at rest in bed for six or eight weeks, by means of Liston's *long splint* (Fig. 121). This needs careful adjustment, but is most satisfactory in its results when properly applied. It should reach from the axilla to about 6 inches below the ankle, and is fixed to the leg or body either by bandages, or much better by two broad sheets, which first firmly envelop the splint, and are then passed round the body, and finally secured by pins to the portion surrounding the splint. Carefully padded poroplastic foot-pieces are placed on either side of the ankle so as to diffuse the pressure, and a handkerchief passed round the foot, and through the prongs at the end of the splint, fixes it in the desired position. A well padded perineal band is next applied, taking its purchase from the tuber ischii, and with its free ends passed through the two holes at the upper extremity of the splint; by tightening and tying these two together, extension of the limb is obtained. Finally, the sheets or bandages are adjusted, and the lower end prevented from moving laterally or rotating by slipping it into a slot between two rectangular plates

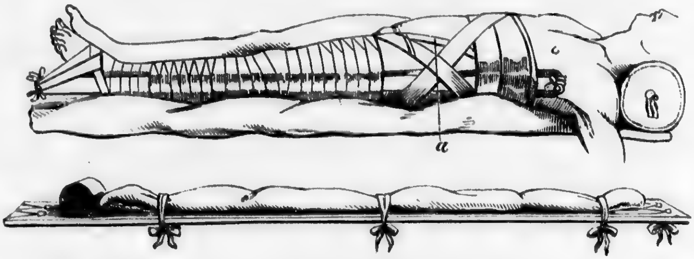


FIG. 121.—LISTON'S LONG SPLINT PADDED AND APPLIED.

a, Perineal band.

of metal screwed to a substantial wooden base, which rests on the bed. The handkerchief and perineal band will need occasional tightening to maintain the required extension, and the latter must be renewed from time to time for purposes of cleanliness, and the parts well powdered with boric acid. Extension may also be obtained by means of a weight and pulley. At the end of six weeks or so the pelvis should be encased in poroplastic material or plaster of Paris, and the patient allowed to get about on crutches, or a Thomas's splint applied.

No attempt should be made to disimpact fractures in old people; rest and quiet should be maintained by applying a long splint without extension, and bony union will usually result. N.B.

In other cases it may suffice to simply lay the limb on a bed between sandbags, and to make extension from the foot. The leg is first swathed with a boracic lint bandage, and then a piece of broad adhesive plaster is applied on either side of the limb, reaching nearly as high as the knee, and with a loose stirrup 4 or 5 inches long below the foot; the plaster is secured by one or two strips of strapping $\frac{3}{4}$ inch wide wound obliquely round the limb above and below, and by a calico bandage. In the stirrup a cross-piece of wood, rather broader than the ankle, is inserted, and a knotted cord carried through a hole in it. To the end of the cord is attached a weight, varying with the requirements of the case, and the cord passed over a pulley fixed to the end of the bed, the lower portion of which is usually slightly raised by placing the legs on blocks, so as to utilize the weight of the body as a counter-extending force. Hodgen's splint, as described below, may also be used in these cases.

Treatment of Extracapsular Fracture.—The long splint with extension is the best apparatus to employ for this condition, good bony union, though with some shortening, usually occurring. In some cases it may be advisable to make extension by weight and pulley from the knee, and to keep the limb slightly flexed, as on a double inclined plane. Perhaps this is best carried out by the use of Hodgen's splint (Fig. 122), which consists of a double iron lateral support which passes down on either side of the limb, and with an iron cross-piece below. It reaches from the upper part of the thigh to below the foot, and is slightly bent at the level of the knee-joint. A simple extension apparatus is applied to the leg, and strips of leather or flannel pass from side to side of the splint, so that the limb when placed thereon is able to rest comfortably within it. An elastic accumulator passes from the cross-piece of the stirrup to the end of the splint. Four hooks are incorporated in the body of the splint, situated one on each side above the knee, and the others about the middle of the leg. Cords are attached to these hooks, and carried up to a point above the limb, from which extension is made by connecting them with a rope which passes over a pulley situated well above the end of the bed, to the end of which a weight is attached. The extending force is thus applied in the flexed position of the limb, counter-extension being secured by raising the end of the bed on blocks.

In young and active individuals, where impaction has occurred, it is quite justifiable to give an anæsthetic, and forcibly break it down, so as to prevent the shortening which would otherwise ensue.

2. **Fractures of the Great Trochanter** are very rare; two varieties are described. In the first, the trochanter may be entirely separated from the rest of the bone without any loss of continuity of the shaft; it is very doubtful whether this can occur apart from a separation of the epiphysis, and it is always due to direct violence. In the second, which closely resembles the extracapsular fracture, the lesion runs from the inner and under part of the neck obliquely upwards and forwards through the base of the trochanter. The lower fragment is drawn upwards and backwards towards the sciatic notch, and forms a projecting mass behind, somewhat simulating a dislocation; the tip of the trochanter can, however, be felt separately, not moving with the shaft. Such cases may be treated by extension with the long splint, or perhaps better by Hodgen's apparatus.

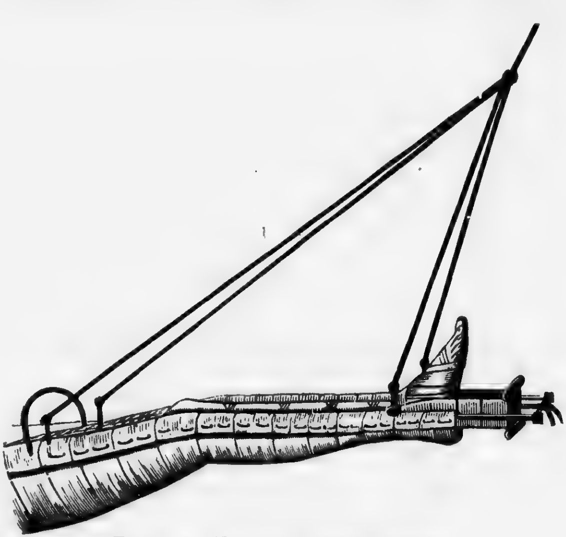


FIG. 122.—HODGEN'S SPLINT APPLIED.

3. **Separation of Epiphyses.**—The whole upper epiphysis has been said to have been separated; but it is very doubtful whether such an accident has resulted, even from direct injury. The epiphysis

of the great trochanter has been separated, as evidenced by the fragment lying loose above and behind its usual position. The great difficulty in fixing it, and the frequently resulting lameness, would justify operative interference to prevent such an occurrence. J. Hutchinson Jr. states that, of eleven recorded cases left to themselves without operation, six suppurated and of these five died.

Fractures of the Shaft of the Femur are extremely common accidents, in spite of the apparent strength of the bone, on account of its exposed position. Any part may be involved, particularly the centre, whilst they occur at the lower end more frequently than at the upper. In the latter situation they are usually due to indirect violence, whilst at the lower end they generally result from direct injury; either form of violence may lead to a fracture at the centre. Muscular action is also responsible for a certain number of cases. Every form of fracture may be met with, the direction and character necessarily varying with the cause of the accident.

In almost every case *displacement* occurs, the direction and amount of which depends not only on the line of fracture, but also on the situation. In the *upper third* (Fig. 123), the small upper fragment is usually tilted forwards by the ilio-psoas, and abducted and everted by the gluteus minimus and external rotators; whilst the lower fragment is drawn upwards and to the inner side of the upper by the hamstrings and adductor muscles, marked eversion also resulting partly from the weight of the foot, and partly from the action of the adductors; but such a complicated displacement is not always evident.

like all fracture

In the *middle third*, if due to indirect violence, the line of fracture slants from above downwards and backwards, causing a simple over-riding of the fragments, or an angular deformity. The lower fragment is drawn upwards and inwards, either in front or behind the upper fragment, and is usually everted. The upper fragment is sometimes tilted forwards. If due to direct violence, the fracture is more often transverse, and any form of displacement may then occur.

In the *lower third* the fractures often arise from direct force, and are transverse; the lower fragment may then be tilted backwards by the gastrocnemii muscles, and compress or rupture the popliteal vessels, causing gangrene (Fig. 124). Oblique fractures, sloping from above downwards and forwards, are, however, met with from indirect violence; in such, the upper fragment is driven into the substance of the quadriceps muscle and may become fixed in it, projecting immediately beneath the skin, whilst the lower fragment is drawn up behind it. If such a case is left unreduced, ununited fracture is likely to ensue; the knee-joint is generally penetrated by the lower end of the upper fragment.

Treatment.—Many more or less complicated plans of treatment have been practised; but simple measures are equally efficacious.

In the *upper third*, where the upper fragment is tilted forwards, constituting a projection under the skin, and when it is too short to be controlled by any splint, reduction of the deformity is accomplished by flexing the thigh, and making extension from the knee, the lower fragment being thus brought into the same axis as the upper. Manipulation will usually correct any lateral displacement. The limb must be confined in this position by some form of inclined plane, and perhaps best by a Macintyre's splint, with a long thigh-piece, and with small straight wooden splints or a piece of Gooch's splinting fixed, if necessary, to the front and outer sides of the limb, over the seat of fracture. The splint is

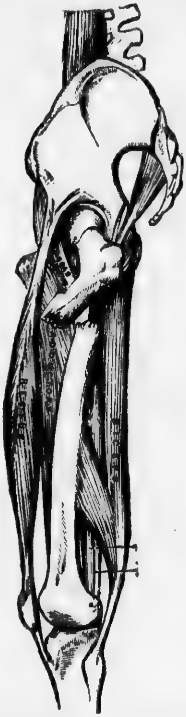


FIG. 123.—FRACTURE OF UPPER THIRD OF FEMUR, SHOWING DISPLACEMENT OF BONE. (FROM GRAY'S 'ANATOMY.')

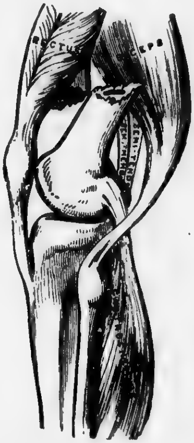


FIG. 124.—FRACTURE OF LOWER THIRD OF FEMUR, SHOWING DISPLACEMENT OF LOWER FRAGMENT BACKWARDS. (FROM GRAY'S 'ANATOMY.')

slung at the knee, the foot-piece being fixed to blocks of wood, a little lower than the level of the knee. If these precautions are not taken, an ununited fracture, with the upper fragment in front of the lower, is likely to occur. Hodgen's apparatus also answers well in these cases.

In the *middle third* of the thigh, where the upper fragment can be controlled by splints, shortening is prevented by simple extension from the foot (p. 411), the thigh being surrounded by pieces of Gooch's splinting, strapped on, which grasp the muscles and keep the parts at rest. The limb in addition is kept between sandbags, or secured on a Liston's long splint.

In the *lower third*, if there is any tendency to displacement of the lower fragment backwards, a Macintyre's splint, with the knee well flexed, should be employed, on the principle of the double-inclined plane, together with a short anterior thigh-piece of Gooch's splinting. When the upper fragment projects anteriorly beneath the skin through the quadriceps, operation alone holds out any prospect of bringing the parts into apposition, the muscular fibres being divided sufficiently to allow the projecting end of the bone to be replaced.

Other forms of extension may be employed besides those we have mentioned, but the above are those most generally adopted. Thus, Thomas's knee-splint may be utilized if accompanied with four short splints to grasp the limb. In children, Bryant's plan of treatment is most excellent; it consists in slinging the limb at right angles to the body after applying a back-splint from the heel to the nates, and short lateral splints, thus obtaining extension by utilizing the weight of the body. By this means the bandages, etc., are kept from being soiled. If a long splint is used for children, a double one (*e.g.*, Hamilton's splint), with a cross-bar below, should be employed. Plaster of Paris and starch bandages may be early applied in adults, but only in the later stages in young children, as they are difficult to keep clean.

Fractures of the Lower End of the Femur.

1. **Transverse Supracondyloid Fracture** is practically identical with that involving the lower third of the femur, just described, since the lower fragment is rotated backwards by the action of the gastrocnemii, thus endangering the integrity of the popliteal vessels, and predisposing to non-union, if the deformity is overlooked.

2. **T- or Y-Shaped Fracture of the Condyles.**—In this a transverse fracture is complicated by a fissure, which runs into the joints, separating the two condyles. The symptoms are much the same as the above, but the joint is distended with blood, the bone may feel broader than usual, and crepitus may be detected. The **Treatment** is the same as for transverse fracture.

3. **Separation of one or the other Condyle.**—This accident arises as a result of direct violence, the line of fracture being oblique. There is no shortening, but the leg may be deflected towards the side injured; the joint is distended with blood, and the fragment displaced upwards. It may move separately from the shaft, and give rise to crepitus. **Treatment** consists merely in straightening the leg, when reposition usually occurs; it is then put up in the extended position.

Occasionally a small portion of the condyle may be detached and lie loose in the knee-joint; when the immediate symptoms due to the injury have subsided, the signs of a foreign body in the joint may become evident.

4. **The Lower Epiphysis of the Femur** may be separated from the shaft in young people; it is not a very rare accident, and closely simulates in its signs those of a transverse fracture, even occasioning gangrene in some cases. The epiphysis is sometimes displaced forwards by the traction of the quadriceps, and the vessels may then be compressed by the lower end of the femur. Suppuration occurs in a fair proportion of the cases. This condition has been mistaken for disease of the knee-joint. The **Treatment** is similar to that for transverse fracture.

5. **Longitudinal and Spiral Fissures** are met with in the femur, running down to the knee-joint, but causing no characteristic symptoms beyond pain and hæmarthrosis. Early passive movement is necessary to prevent impairment of the functions of the joint.

Fractures of the Patella.

The patella may be broken in two very distinct ways, viz., by muscular force and by direct violence, and the conditions produced are so different that a separate description is necessary.

1. **Fractures by direct violence** may traverse the bone in any direction, but are most often vertical or star-shaped, and possibly comminuted. They are frequently incomplete, *i.e.*, mere fissures of the front of the bone, and as a rule the fibrous aponeurosis or capsule covering it is uninjured, thereby preventing any displacement of fragments. There is a good deal of subcutaneous bruising, and perhaps some effusion into the joint, and on careful palpation a fissure may be detected. Crepitus can be obtained if the fracture is complete. All that is needed in the way of **Treatment** is the application of a back-splint, and rest, with perhaps evaporating lotions. Passive movements must be commenced early where there has been much effusion into the joint.

2. **Fractures due to muscular force** constitute a very different class of injury, since they are always transverse, usually complete, and also involve the fibrous aponeurosis, so that considerable displacement occurs.

Mechanism.—When the knee is semi-flexed, the patella is poised upon the front of the condyles of the femur, resting upon the middle of its articular surface; in such a position any sudden and violent contraction of the quadriceps takes it at a disadvantage, and may succeed in snapping it. A sudden attempt to recover one's equilibrium after having slipped is the usual way in which this accident is produced. Possibly in some people there may be some predisposing weakness of the bone, as cases are not rare in which the other bone yields subsequently, although perfect functional repair has been obtained in that first broken. The fragments are sometimes almost equal in size, but may vary widely; and either of them may be again divided vertically, or comminuted (Fig. 125).

The **Signs** of this fracture are very evident, consisting of almost complete loss of power in the limb, ecchymosis and pain, distension of the joint with blood, and separation of the fragments, which can be readily detected and sometimes brought into apposition with crepitus (Figs. 125 and 126). This displacement, at first due to muscular action, is maintained by the effusion of blood, as also later by synovial exudation. Union by bone is rarely obtained under ordinary circumstances, a fact explained partly by the separation of the fragments, and partly arising from the fibrous aponeurosis or capsule yielding at a different level to the bone, the loose end being carried in and fixed between the fractured surfaces. Fibrous union is the usual result, and when this is short and strong, it may be exceedingly satisfactory; but more commonly the bond of union yields when the limb is used, so that the two fragments are once again separated, and merely

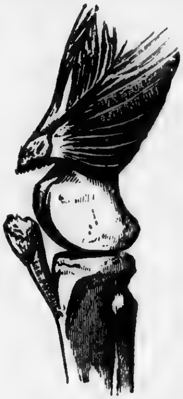


FIG. 125.—FRACTURE OF PATELLA, AND SEPARATION OF FRAGMENTS. (FROM GRAY'S 'ANATOMY.')

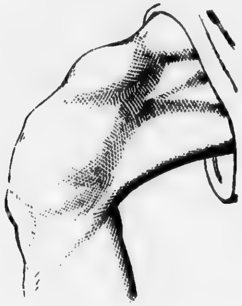


FIG. 126.—APPEARANCE OF KNEE AFTER FRACTURE OF PATELLA.

bridged over by a fibrous band, the joint being often weak and more or less powerless in consequence.

The **Treatment** of these cases has been a matter of great discussion, and many plans have been adopted, which may, however, be grouped under three headings, viz., treatment by retentive apparatus, by subcutaneous operation, or by the open method.

1. *Simple retentive apparatus* may be employed beneficially in the simpler cases, where the fragments are not widely separated, and can be readily brought into contact and maintained in apposition.

Some surgeons depend mainly upon plaster of Paris to effect this. If there is but little effusion, the limb is extended, swathed in cotton-wool retained by a flannel bandage, and over this the plaster casing is applied. As the apparatus becomes loose owing to atrophy of the muscles, it will need readjustment. The patient is kept in bed for three or four weeks, but the plaster is retained for as many months, and after that a knee support, such as the Middlesex splint (*vide infra*), is kept on till twelve months have elapsed. Where there is much effusion after the accident, the limb is placed on a back-splint and kept cool by ice or evaporating lotion, until the fluid has been absorbed; or the joint may be aspirated in order to hasten matters. The plaster is then applied, and the same subsequent routine followed.

Others simply employ a back-splint with a foot-piece, and endeavour to bring the fragments into apposition by means of pads placed above and below, and drawn together by strapping or bandages in a figure-of-8 fashion. Wood's splint may be used for this purpose; it has two hooks placed on the under surface, so as to give points of support to the bandage or strapping. The objection to this method of treatment consists in the fact that the arteries which supply the bone run along its upper and lower borders, so that the necessary pressure to retain the pads must inevitably compress them, and seriously interfere with the nutrition of the fragments. To obviate this difficulty various appliances, such as Manning's splint, have been introduced, but are now seldom utilized.

In the so-called Middlesex plan of treatment a large piece of moleskin plaster is placed over the front and sides of the extensor surface of the thigh, reaching halfway up to the groin, and terminating below in two lateral elongated ends or tags, to which elastic traction is applied. The limb is put on a back-splint, with a foot-piece, beneath which the elastic accumulator is tied so as to tighten it. Removal of the effusion in the joint may be hastened by the use of the aspirator. At the end of about six weeks the patient is allowed to get about in a plaster of Paris casing, and then, about three months after the accident, a special knee-splint is substituted, which allows of only a small amount of mobility at first, but, by filing away a stop, this can be gradually increased, until a full range of movement is permitted.

In all these methods of treatment it is probable that only fibrous union is obtained. If efficient after-treatment is employed, this will not yield; but where the patient is neglected, the bond of union is likely to stretch, and the fragments again become separated, with considerable impairment to the utility and firmness of the joint.

2. To ensure more accurate apposition and a firmer union, and yet to avoid the risks necessarily associated with an open operation, various *subcutaneous operations* have been adopted. (*a*) Barker recommends *antero-posterior suture* of the bone (Fig. 127). An opening is made with a tenotomy knife into the joint just below the lower segment, through which any effused blood or synovia can be squeezed, and along which a curved hernia needle is passed, traversing the articulation from below upwards, and being made to emerge through the skin above the upper fragment. A piece of sterilized silver wire is then carried back under the bone. The needle is again inserted at the same spot below, and carried in front of the bone under the skin, emerging at the same point above. The upper end of the wire is threaded through it, and by this means brought out at the lower opening. The bone is thus encircled, and by tightening and twisting the wire the fragments are brought into apposition. The ends are cut off and pushed back under the skin. The punctures are treated antiseptically, and the limb placed on a back-splint for a week or so, when passive movement is commenced, the patient being allowed to walk about at the end of the second week, and discarding all apparatus at the end of five weeks. (*b*) *Circumferential suture* (introduced originally by Butcher, of Liverpool) is also practised (Fig. 128), the wire in this case passing round the bone from side to side. A somewhat longer period of after-treatment is needed in these cases. (*c*) Mayo Robson, of Leeds, inserts knitting needles through the muscle and tendon above and below the fragments, and draws them together by elastic bands passed over

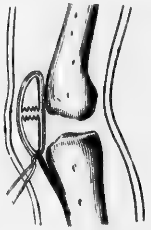


FIG. 127.—BARKER'S METHOD OF SUBCUTANEOUS SUTURE AFTER FRACTURE OF PATELLA.

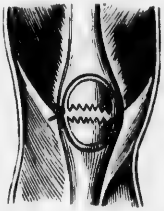


FIG. 128.—CIRCUMFERENTIAL SUTURE FOR FRACTURE OF PATELLA.

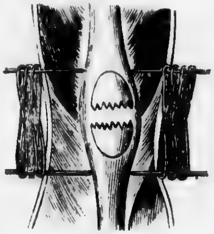


FIG. 129.—MAYO ROBSON'S METHOD OF DEALING WITH FRACTURED PATELLA.

the ends (Fig. 129). (*d*) Malgaigne's hooks (Fig. 130) are still recommended by some surgeons, but there is no advantage in their use, and there are some very obvious objections to inserting them into the substance of the fragments.

Necessarily, a certain element of risk is admitted in the use of any of these subcutaneous operations, and the surgeon has to ask himself whether he is doing the best for his patient by utilizing such proceedings, granting that it is advisable to interfere at all. Personally, we are distinctly of opinion that, if it is justifiable to incur any risk, it is best to proceed by the open method, since in none of these can the fragments be brought into accurate apposition, owing to the impossibility of removing the interposed portion of fibrous capsule, which is always curled in over one of the broken surfaces, and, moreover, the joint cavity cannot be cleared of the blood-clot which may have collected within it. Impressed by the confidence derived from a thorough and efficient application of aseptic principles, we cannot but conclude that, if it is desirable to do more in a case of fractured patella than apply mere retentive apparatus, the patient's welfare is best consulted by adopting—

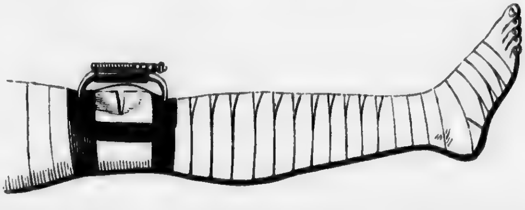


FIG. 130.—MALGAIGNE'S HOOKS APPLIED FOR FRACTURED PATELLA

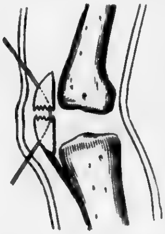


FIG. 131.—POSITION OF SILVER WIRE IN OPEN OPERATION FOR FRACTURED PATELLA.

3. The *open plan of treatment*, re-introduced by Lord Lister. It consists in freely exposing the interior of the articulation, clearing the joint of all blood-clot, removing all tags of fascia or aponeurosis, and wiring the fragments securely together.

No surgeon should attempt this operation unless well assisted and thoroughly *au fait* with the details of antiseptic work, as the risks run are considerable, although the benefits to be derived are correspondingly great. At King's College Hospital this practice is now extensively and almost exclusively followed, and the results, at any rate in the more recent cases, are most satisfactory, no instance of serious mischief from the operation having arisen for the last ten or fifteen years. A longitudinal incision is usually adopted, although a flap may be with advantage dissected up, exposing the whole bone. All blood-clot is removed, and the fractured surfaces cleared of all clot and fibrous shreds, which are very often adherent. Tracks for the wire sutures are now made by a bradawl, extending from the upper or lower end through the centre of the bone, so as to emerge on the fractured surface just in front of the articular cartilage; should the awl emerge at different levels on the faces of the fragments, cartilage or bone must be chipped away to make a channel in which the wire may lie, so that the two fragments are exactly level, with no inequality of the articular cartilages. A thoroughly sterilized silver wire of suitable thickness is then passed; the bones are brought into apposition, and the wire twisted into a knot or loop, which is hammered or pressed down into the periosteum, so as to prevent it from projecting under the skin and causing irritation. A second wire is sometimes needed in order to prevent rotation of the fragments. The wound is closed, and the limb kept on a Gooch's splint for eight days, when passive movement is commenced, and by the end of a fortnight the patient is allowed to walk. Some surgeons keep the limb immobilized for six weeks, and such a practice is certainly desirable in complicated cases, where several fragments have to be dealt with.

It is perhaps advisable not to undertake this operation immediately after the accident. The limb should be kept at rest on a back-splint, and an icebag applied for a week or ten days, so as to allow the joint to recover from the effects of the injury it has sustained. There is much less risk of septic complications if this precaution is adopted.

In *old cases* where the fibrous union has stretched, and the utility of the limb is seriously impaired, the open operation holds out the only hope of helping the patient, although it is often associated with considerable difficulty. The fibrous tissue must be dissected away, and the ends of the bones freshened (if need be with the saw). To obtain apposition, the upper fragment must be freely detached from the femoral condyles, to which it is very often adherent, and the rectus muscle, which is secondarily contracted, may need to be partially divided. The limb should subsequently be well raised to relax the quadriceps and thus diminish tension on the bond of union, and lowered inch by inch on succeeding days. The muscle is thus stretched to accommodate itself to the altered conditions.

If the fragments cannot be absolutely brought together, the same treatment may be adopted, and the patient allowed to get about with the silver wires holding the fragments together; the quadriceps is stretched by this means, and a second operation performed later may prove successful in gaining bony union of the fragments. Such treatment has been adopted with great success by Lord Lister.

Fractures of the Leg.

In the lower leg fractures may be due to direct or indirect violence, and may involve either the tibia or fibula alone, or both bones.

Fractures of the Tibia alone.—Several varieties are described. (*a*) The *upper end* is usually broken as a result of direct violence, the line of fracture being transverse; it is by no means a common accident. The characteristic features are not always very evident at first, since considerable swelling and ecchymosis are produced. A few cases of vertical separation of one of the tuberosities are also on record. **Treatment** consists in placing the limb upon a back-splint, *e.g.*, Macintyre's, and, as a rule, satisfactory union ensues, though possibly with some distorsion. (*b*) Fracture of *the shaft* of the tibia, apart from the fibula, is usually caused by direct violence. It is transverse in the upper part of the bone, and oblique below. The fracture is diagnosed by the surgeon feeling an inequality on running his fingers along the shin, together with pain at this spot on firmly grasping the bones above and below. There is often but little displacement, since the fibula acts as a splint. The **treatment** consists in the application of back or side splints for a few days until the swelling has gone down, and then the limb may be put up in plaster. If the bones have been comminuted, treatment will be more protracted. (*c*) The *internal malleolus* is occasionally separated as the result of direct injury, apart from any other osseous lesions, constituting what is known as 'Wagstaffe's fracture.' There is comparatively little displacement, but the malleolus is loose, and crepitus can usually be obtained on moving it backwards and forwards. Union by fibrous or osseous tissue ensues, but usually in a more or less abnormal position, as a consequence of which the integrity of the ankle-joint is disturbed, and weakness or lameness may follow. **Treatment** consists in the application of lateral splints. If there is any difficulty in keeping the parts in apposition, an incision should be made, and the malleolus wired or pegged to the tibia.

Fractures of the Fibula alone are by no means uncommon, usually occurring as a result of direct violence. There is no displacement or deformity, but the patient complains of pain localized to some particular spot, and this can be usually elicited by grasping the bones above and below, and compressing them laterally ('springing' the fibula). Sometimes the diagnosis is extremely uncertain, and then the X rays may prove useful. Thus, Fig. 132 represents a skiagram of a leg, showing distinctly a fracture of this bone, which occurred in a medical man, although one or two surgeons had given their opinion that no fracture existed. **Treatment** consists in immobilizing the limb in a plaster case.

Fracture of both Tibia and Fibula is a very common accident, due to both direct and indirect violence; if to direct violence any part may be injured, both bones yielding at the same level;

but if in consequence of an indirect injury the tibia usually gives way at its weakest part, viz., at the junction of its middle and lower thirds, and the fibula at rather a higher level. The fractures are often oblique, the lower end of the upper fragment of the tibia being sometimes shaped like the mouth of a clarionet (fracture *en bec de flûte*), and may run in any direction according to the character of the violence, although the obliquity is most frequently directed downwards, forwards, and inwards. The lower fragment is generally drawn upwards on account of the contraction of the powerful calf muscles, and often rotated outwards from the weight of the foot. The ordinary characteristics of a fracture are very evident, and but little difficulty can ever be experienced in making a diagnosis. The fracture is likely to become compound when due to indirect violence, owing to the sharp end of the oblique fragment of the tibia, usually the upper, penetrating the skin.

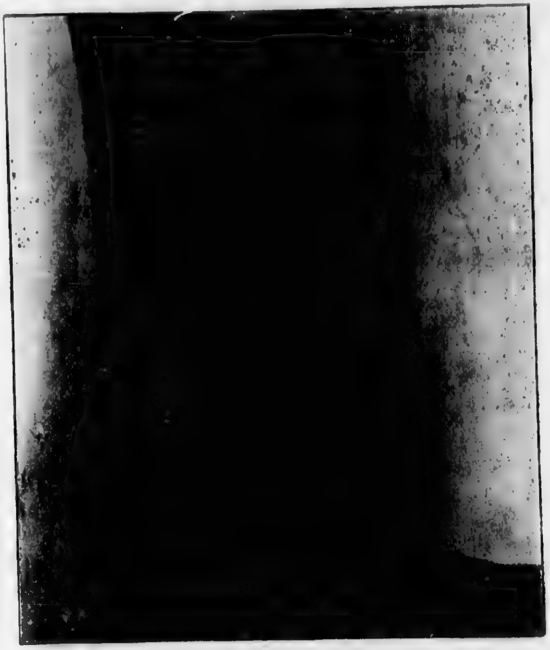


Fig. 132.—Skiagram of Fractured Fibula from Behind.

Treatment.—Reduction is accomplished by flexing and fixing the knee, so as to relax the muscles of the calf, and then making traction on the foot and manipulating the parts into position.

The tendo Achillis may, if necessary, be divided. It will usually suffice to put up the limb in a pair of side-splints, such as Cline's, the longer one with the foot-piece being of course placed on the outer side. In other cases it may be better to apply a broad posterior splint with a rectangular foot-piece, *e.g.*, Macintyre's, and two lateral splints. Other surgeons have recommended an anterior wire splint, extending from above the knee to the foot, the leg being subsequently slung in the flexed position. This may be advantageously modified by combining it with an additional casing of plaster of Paris. Whatever treatment is adopted, it is necessary to see that the length of the limb is as far as possible maintained, and that no rotation of the lower fragment is present. To ensure absence of rotation, all that is needed is to note that the inner aspect of the great toe, the subcutaneous surface of the internal malleolus, and the inner border of the patella, are in the same line, and correspond with the opposite limb. Union will be sufficiently advanced in two or three weeks to allow of the limb being put up in a plaster casing, which must, however, be retained for at least another month, and even then a good deal of lameness is likely to persist, which will need subsequent massage.

Considerable permanent interference with the functional utility of the limb is likely to follow any such accident, and to prevent this occurrence, it has been suggested that all such fractures should be cut down on, and the tibial fragments secured in apposition by steel screws or wire. Such treatment is, in our opinion, scarcely justified as a routine procedure.

Fractures in the neighbourhood of the Ankle-joint, and involving that structure, are of considerable importance. They are usually produced by indirect violence, the patient's foot slipping, and leading to lateral displacement of the ankle, the fracture being a secondary result. They would therefore be better described as **Fracture-dislocations at the Ankle-joint.**

1. *Displacement of the Foot outwards* is by far the most common variety, constituting what is known as *Pott's Fracture*. It usually results from the patient slipping on the inside of the foot, as from off a kerbstone. The astragalus is thereby forcibly driven against the inner aspect of the external malleolus, and tends to displace that portion of bone outwards. The force is thence transferred to the fibula, which bends and breaks at its weakest spot—that is, about 3 inches above the tip of the malleolus—the upper end of the lower fragment being displaced inwards towards the tibia. Where the inferior interosseous tibio-fibular ligament remains intact, the foot itself cannot be displaced upwards, but is merely rotated outwards.

The amount of injury inflicted on the tissues to the inner side of the foot, or in the tibia, warrants us in describing four distinct fractures, to the first two only of which the name Pott's fracture is correctly applied: (*a*) In the first degree, merely the internal lateral ligament is torn through (Fig. 133); the intact malleolus can then be felt projecting through the skin. (*b*) In the second degree, the malleolus itself is torn off, and a distinct sulcus can be felt between it and the lower end of the tibial shaft (Fig. 134). (*c*) The third degree is a much more serious lesion, constituting what is sometimes known as *Dupuytren's Fracture*. The interosseous tibio-fibular ligament here yields, or the flake of bone to which it is attached is torn off; the foot, carrying with it the lower portion of the fibula, and the superficial flake of the tibia, which has been detached, is displaced upwards and backwards to a much greater degree than in either of the other forms, whilst on the inner side either the ligament or the malleolus may yield (Fig. 135). (*d*) The fourth degree consists in the usual type of fracture of the fibula, associated with an almost transverse fracture of the tibia, just above the base of the inner malleolus (Fig. 136). In this variety, the lower end of the shaft of the tibia projects beneath the skin, and is very likely to be mistaken for the tip of the malleolus; if this error is made, and the fracture allowed to unite without proper rectification, considerable deformity will result.

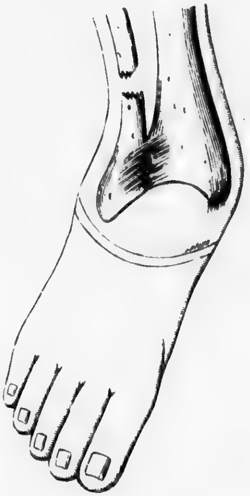


FIG. 133.—ORDINARY POTT'S FRACTURE WITH RUPTURE OF INTERNAL LATERAL LIGAMENT.

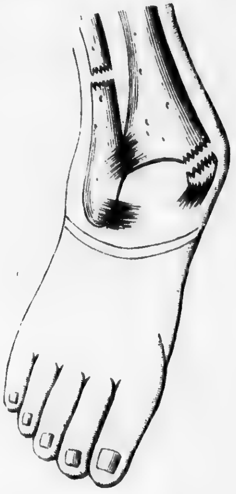


FIG. 134.—POTT'S FRACTURE WITH INTERNAL MALLEOLUS TORN OFF.

In rare instances, the lower end of the tibia may project through the skin, thus rendering the fracture compound.

2. *Displacement of the Foot inwards.*—When the patient slips on the outer aspect of the foot, the astragalus is forcibly driven against the inner malleolus, which may be impacted into it. The outer malleolus is dragged inwards with the foot, and owing to the integrity of the inferior tibio-fibular ligament, which acts as a fulcrum, the fibula yields at the same spot as in Pott's fracture. The foot is displaced inwards, and perhaps slightly backwards, and the fragments of the fibula tend to project externally.

Treatment.—In reducing these fractures, traction should be made upon the foot after the tension of the calf muscles has been relieved by flexing the knee, or by tenotomy of the tendo Achillis. Before applying the splints, careful attention must be given to the following points: (*a*) The foot must be maintained at right angles to the leg; (*b*) the heel must not project unduly backwards; and (*c*) the foot must not be rotated on the leg—*i.e.*, the inner surfaces of the great toe, internal malleolus, and patella must be in the same line. A pair of Cline's splints is often sufficient to steady the parts. Some cases are better treated, however, by a Dupuytren's splint (Fig. 137), which is really a Liston's long splint on a small scale. It reaches from the knee to below the sole of the foot, and is placed on the inner side of the limb, the patient lying on the sound side during its application. A firm pad extends

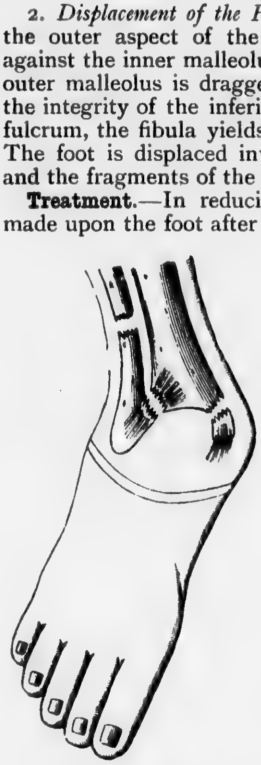


FIG. 135.—DUPUYTREN'S FRACTURE.

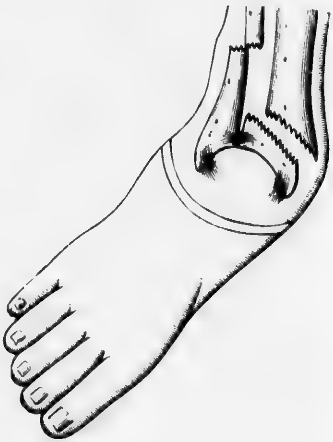


FIG. 136.—FRACTURE OF LOWER END OF FIBULA AND TIBIA SIMULATING POTT'S FRACTURE.

down as far as the base of the internal malleolus, and over this as a fulcrum the foot is drawn inwards by a handkerchief applied around the ankle, and tied to the notches at the end of the splint. The foot being thus fixed, the upper end of the splint is bandaged to the limb. Any tendency to backward displacement of the heel may be counteracted by the use of a Macintyre's back-splint, or by the application of a Syme's anterior horseshoe splint, which can be used in combination with a Dupuytren. It consists of a flat piece of wood, well padded, extending from the knee to the ankle along the crest of the tibia; the lower end is shaped like a horseshoe, the two limbs passing one on either side of the foot. A handkerchief or piece of bandage is then applied, with its centre over the point of the heel; it passes up on either side between the splint and the foot, winds over the former structure, and is tied behind the heel, which is thus lifted forwards. As soon as possible, the limb should be put up in water-glass or plaster of Paris.

In the simpler forms, early massage may be employed, and then all the retentive apparatus necessary is some adhesive plaster applied so as to cover in and encase the foot and ankle.

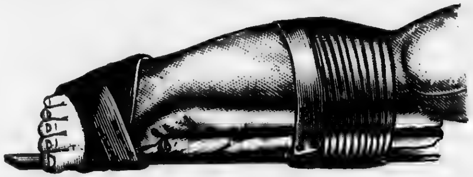


FIG. 137.—DUPUYTREN'S SPLINT APPLIED FOR POTT'S FRACTURE. (TILLMANNS.)

Fracture of the Os Calcis may result from direct violence, such as a blow on the heel, or possibly from muscular action, the epiphysis being then separated, or the shell of bone into which the tendo Achillis is inserted being torn off. The fragment thus separated is displaced upwards by the contraction of the calf muscles, and the deformity produced is very evident. If the line of fracture passes through the body of the bone, there is usually no displacement, owing to the attachment of the interosseous and lateral ligaments; crepitus can sometimes be obtained on firmly grasping and moving the fragments. **Treatment** consists in immobilizing the foot in a plaster case if there is no displacement; but where the posterior part of the bone is drawn upwards, it must be approximated to the rest of the bone by flexing the leg, and thus relaxing the calf muscles, or even by tenotomy. A more satisfactory result may, however, be obtained by cutting down, and wiring or pegging.

Other bones of the tarsus are occasionally fractured, but these lesions require no detailed description.

CHAPTER XV.

INJURIES OF JOINTS—DISLOCATIONS.

Sprains and Strains.—When, as the result of sudden violence, some of the ligamentous fibres around a joint are ruptured or stretched, the joint is said to be sprained or strained. The accident itself is associated with pain of a most severe character, and is followed by more or less hæmorrhage into the surrounding tissues, or into the articular cavity. An attack of synovitis, varying in severity, generally ensues, and may lead to persistent weakness and pain in the joint, either as the result of the formation of adhesions, or owing to the imperfect repair of the ligaments. If the condition thus induced is neglected, it may originate tubercular disease in those who are so predisposed, whilst osteo-arthritis is a by no means uncommon sequela. If the patient is in a bad state of health at the time of the injury, it is possible that an attack of acute infective arthritis may be lighted up, in the same way as an acute infective necrosis may follow contusion of a bone.

Treatment.—The joint should be firmly supported by a bandage as soon after the accident as possible, and cold or evaporating lotions applied. In the slighter cases, all that is needed is to strap the joint or use elastic pressure, the patient being allowed to use the limb at the end of a day or two; but in severe sprains it is better to keep the part absolutely at rest for some days, for neglect in the early stages may give rise to as much, if not more, trouble than if the limb had been fractured. Friction with stimulating liniments, massage, and douching the joint alternately with hot and cold water, are subsequently useful in restoring the limb to full functional activity. When synovitis supervenes, the treatment suitable for that condition must be adopted (see p. 558).

Penetrating Wounds of Joints are often accompanied by an escape of synovia, which is recognised as a glairy, oily fluid, floating perhaps on the surface of the blood; if, however, the aperture is small, this may not occur. It is always followed by a certain amount of inflammation, the severity and extent of which depend on whether the joint is infected and the character of that infection. If no infection has taken place, and the joint is maintained in an aseptic condition, a simple synovitis ensues, and soon passes off; if, however, micro-organisms have entered, acute septic arthritis will probably supervene, leading to destruction and disintegration of the joint. (For symptoms and treatment, see p. 564.) A penetrating wound, even if untreated, does not necessarily become septic; thus, if the lesion is produced by a small clean instrument, and especially if this is inserted in a slanting direction, so that the wound is valvular, or if the incision is a large one, allowing free vent to all discharges, recovery without septic inflammation is possible.

Considerable difference of opinion has been expressed as to the necessity for accurately determining whether or not the synovial membrane has been punctured. Speaking generally, one would recommend that if the wound is small, and the surgeon has reason to believe that the instrument inflicting it has been aseptic, the external skin should be thoroughly purified, and an antiseptic dressing applied. A careful watch must be kept upon the condition of the joint, and upon the temperature of the patient; as soon as any signs of septic arthritis manifest themselves, free incisions are made into the joint, so as to relieve tension and allow the cavity to be irrigated. If, however, the wound is inflicted by a dirty instrument, and there is some doubt as to whether the joint has been penetrated or not, it is most important to make certain of this fact. For this purpose the wound should be enlarged, so that the depths of it may be purified, and then carefully examined. If it is found that the cavity has been opened, the aperture should be increased in size so as to allow it to be washed out and a drainage-tube inserted; if acute arthritis supervenes, it must be treated in the usual way.

Dislocations.

Although the term 'dislocation' is most commonly applied to a forcible displacement of one of the bones entering into an articulation, as the result of an injury, it must not be forgotten that congenital and pathological displacements also exist.

Congenital Dislocation.—This term is applied generally to any defect of a joint present at birth, but is really a misnomer, since the condition is almost always due to an error of development, as a result of which a normal location of the bony constituents has never been present, and hence a *dis*location cannot have taken place. The hip-joint is that most frequently affected; but similar malformations have occurred in the shoulder, wrist, and jaw, whilst the patella may be congenitally absent or displaced.

Congenital Dislocation of the Hip is by no means rare, and is usually due to a defective development of the iliac portion of the acetabulum, which, instead of being hollowed out and cup-shaped, is shallow and flattened. The head of the bone, having therefore no opposing surface to rest against, is misshapen, and travels up over the dorsum ilii, perhaps being found close to the crest, where a false joint develops (Fig. 138A). The malformation often passes unnoticed until the child begins to walk, and then the characteristic signs become evident. It is frequently bilateral, more rarely unilateral. The limb is shortened and flexed on the pelvis, owing to the traction of the ilio-psoas muscle, necessitating a considerable amount of lordosis to maintain the body in a vertical position (Fig. 138). The patient's gait is of a curious waddling character, which becomes very marked if only one side is affected. Since the head of the bone is only maintained in position by its ligamentous and muscular attachments, any injury of the limb is likely to be followed by a subacute attack of synovitis, which in these patients is frequently seen.

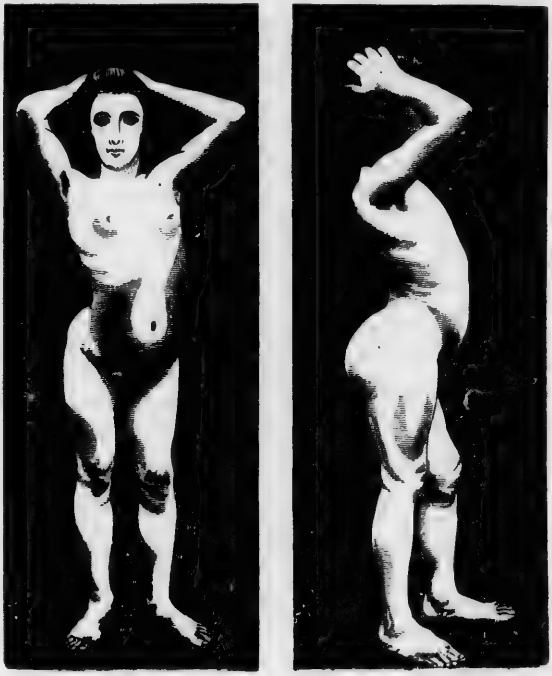


FIG. 138.—CONGENITAL DISLOCATION OF THE HIP.

The **Treatment** is not very satisfactory. Prolonged extension, say for two years, may be of use; and a mechanical support, pressing the head of the bone downwards, may be applied. Attempts at reduction of the displacement are not of the slightest benefit, unless undertaken at a very early age, seeing that the cause of the deformity lies in a defective formation of the acetabular cavity. In children under five years reduction may, however, be accomplished by flexing, abducting, and rotating the limb outwards under chloroform. In those who have walked the muscles and tendons may be contracted, and to overcome this preliminary treatment by extension, or even tenotomy, is necessary. The reduction is sometimes accomplished with a snap, and the new position is maintained by keeping the leg abducted, and only bringing it down to the normal by slow degrees. This plan of Paci's has now been well tested, and the results have been very gratifying; the great essential for success is to commence early, if possible before the patient has walked.

FIG. 138A.—SKIAGRAM OF CONGENITAL DISLOCATION OF HIP.

The deformed head lies higher than is natural, and the iliac bone is atrophied.

In older children (from five to ten years) operative treatment can be undertaken with some prospect of success. Hoffa and Lorenz have been the great exponents of this proceeding, though for children under five years they both admit the value of Paci's method. Their operations consist in opening the joint from the back and front respectively, shaping up the head of the bone, enlarging the acetabulum so that the head can be replaced in it, and dividing any tense structures which prevent reduction. The limb is subsequently immobilized in a position of eversion and abduction, but for as short a time as possible. Even if ankylosis results, the patient's gait is considerably improved.

Pathological Dislocations are produced as the result of some intra-articular affection, *e.g.*, tubercular disease, osteo-arthritis, Charcot's disease, etc. It is unnecessary to describe them here.

Traumatic Dislocations.

Causes.—These are divided into the predisposing and exciting. Under the former head may be included some anatomical peculiarity of the joint, such as the shallow socket of the glenoid cavity, or some weakness of the muscles or ligaments which control the movements of the articulation. Dislocations are exceedingly rare in children, owing to the fact that any violence directed to a joint or its neighbourhood is likely to lead to an epiphyseal separation. Moreover, in old people the bones become brittle, and thus fractures, rather than dislocations, are produced; hence the latter lesions are almost limited to adults, and, owing to their greater exposure to injury, occur in men rather than in women.

The **Exciting Causes** are the application of external violence and muscular action, acting alone or in combination. The former may be direct or indirect, but much more commonly the latter, the force being applied at some distance from the joint implicated, and driving the bone out of its socket. Muscular action by itself can only produce dislocation in certain joints, which by their peculiar conformation are predisposed to it; the patella and condyle of the jaw are the bones most often affected in this way. If, however, the ligaments of a joint have been stretched by previous disease or displacement, recurrent dislocations, the result of muscular action, are not unlikely to ensue.

The term *complete dislocation*, or *luxation*, is applied to that condition in which the articular surfaces of the bones are completely separated from one another. An *incomplete dislocation*, or *subluxation*, is one in which the surfaces are only partially separated.

A *compound dislocation* is one in which the skin has been ruptured and a communication established with the external air. A *complicated dislocation* is one in which there has been some associated injury of vessels, nerves, or viscera. The term *fracture-dislocation* is one applied to a condition in which a dislocation is complicated by a fracture of one or both ends of the bones.

The **Signs** of a dislocation are as follows: (1) The evidences of a local trauma, *e.g.*, pain, bruising, and swelling of the soft tissues, due to their laceration and the effusion of blood into them; the amount of this varies in different cases: (2) deformity of the limb due to the articular end of the displaced bone being in some abnormal position, where it can often be felt and sometimes seen: and (3) preternatural immobility in the affected joint, and hence impairment of function in the limb. The degree to which this obtains is necessarily variable, but, as a rule, it is very marked; if, however, fracture is also present, passive movements are possible, though associated with pain and crepitus.

The **Effects** produced by a dislocation extend to all the structures entering into and surrounding the site of injury. The ligaments are partially or completely torn; the bony surfaces are not unfrequently fractured, especially in closely-fitting hinge joints, such as the elbow and ankle; the cartilages may be bruised, or portions of them detached, and neighbouring muscles and tendons lacerated and displaced; adjacent vessels and nerves are often contused or compressed. Considerable effusion of blood is always present, infiltrating the whole area involved.

The character of the injury explains the difficulties that are met with in its reduction. These arise from two main causes: (*a*) The anatomical structure of the joint and its ligaments, resulting in the hitching of bony prominences against one another, whilst the head of the bone does not always lie opposite the hole in the capsule through which it originally passed. In a few cases the end of the bone may be grasped by neighbouring ligaments and muscles in such a way as to render its replacement a matter of the greatest difficulty. (*b*) The contractions of neighbouring muscles also constitute an obstacle, which, though formerly difficult to counteract, is now readily overcome by the use of anæsthetics. Not only does the patient maintain the limb in a condition of rest by a voluntary tonic contraction, but it tends to become fixed by the involuntary passive tension of the displaced muscles. Moreover, spasms of a clonic type may arise from the direct or reflex irritation of nerves, and these the patient is quite incapable of controlling.

When once reduced, Nature soon restores the part by a rapid process of repair, so that in many cases no permanent lesion remains, although in some the vent in the capsule does not heal firmly, leaving the joint weak and liable to a recurrence, while cicatricial contraction of the injured ligaments and muscles may cause some loss of mobility.

If a dislocation is *allowed to remain unreduced*, anatomical changes are sure to follow. The true articular cavity is shallowed and partly filled up by a transformation of its cartilage into fibrous tissue. The displaced head of the bone becomes adherent to the structures amongst which it lies, and, as the result of a plastic inflammation, either dense fibrous adhesions are formed, or a new false capsule. The articular cartilage is eroded, and the exposed bone often eburnated and sclerosed, whilst, as a result of chronic periostitis, the end of the shaft may be considerably deformed. The portion of bone, upon which the displaced head rests, undergoes changes, partly atrophic (from pressure), partly hypertrophic (as a result of chronic periostitis), whereby a new socket is produced (Fig. 139). Neighbouring muscles become secondarily shortened, and accommodate themselves to the abnormal position of the limb. Tendons which have been torn gain fresh attachments. These changes necessarily interfere more or less seriously with the power of the limb and movement of the joint.

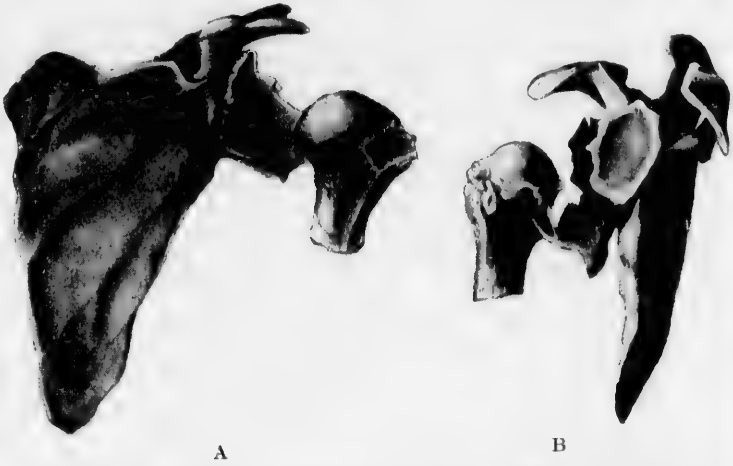


FIG. 139.—OLD-STANDING DISLOCATION OF THE SHOULDER, SHOWING ATROPHY OF TRUE GLENOID CAVITY, TOGETHER WITH FORMATION OF NEW JOINT AND ALTERATION IN SHAPE OF HEAD OF BONE. (FROM COLLEGE OF SURGEONS' MUSEUM.)

Treatment.—The treatment of dislocations consists in the reduction of the displaced head of the bone with as little delay as possible. There are two chief methods of gaining this end, viz., manipulation and extension.

Manipulation is always the best means to employ where practicable, less injury being sustained by the surrounding tissues. It consists in moving the limb in such directions as shall cause the displaced articular end to retrace the course that it has already taken, through the rent in the capsule to its normal position. Ball-and-socket joints, such as the shoulder and hip, are more amenable to this method of treatment than hinge joints.

Anæsthesia may be needed in difficult cases. The special manipulations required in any particular instance are detailed under the various joints.

Extension is employed to overcome muscular and other forms of resistance, so as to draw the bone back into its original position. In order to make this effectual, the parts above the dislocation are steadied by some *counter-extending* force applied either by the hands of an assistant, or by a belt or towel, or by the knee or foot of the surgeon. Extension may be made either by the hands of the surgeon, or a firmer grip may be maintained, and greater force used, by applying a bandage or a jack-towel to the limb by means of a clove-hitch. In a few cases, the force may be exerted through some form of multiplying pulley, fixed at one end to a hook or staple, and at the other end to the loop of a towel or bandage attached to the limb. When any such contrivance is employed, precautions must be taken to prevent the soft tissues of the limb from being injured. A useful plan consists in applying a damp bandage at the point from which traction is to be made, and over this a thick skein of worsted in the form of a clove-hitch, the loop being attached to the hook of the pulley. The extension must be made continuously and steadily; no jolting or jerking action is allowable, or considerable mischief may ensue. Since the introduction of anæsthetics, however, pulleys have been very rarely required, except in dealing with old-standing cases.

Reduction, however produced, is usually accompanied by a sudden and distinct snap due to the contraction of muscles, unless the patient is deeply under an anæsthetic, and the muscles absolutely relaxed. The limb is subsequently kept at rest for some days, so as to allow the rent in the capsule to heal. Cooling lotions are applied to reduce the swelling, and at the end of ten days or a fortnight passive movements commenced, together with friction and massage of the soft parts.

The treatment of unreduced dislocations is often a matter of considerable difficulty. Attempts to reduce them may be undertaken up to two or three months, but no undue violence is permissible, owing to the fact that adhesions to the neighbouring parts may thereby be ruptured, and the main vessels or nerves endangered. The use of pulleys has been sometimes recommended, but so many accidents have been reported, varying in severity from laceration of the skin to actual avulsion of the limb, that it is better to discontinue such treatment if it has failed on its first application.

The amount of mobility possible in an unreduced dislocation varies a good deal in different cases, and the character of the treatment is mainly governed by this. If movement is tolerably free, and not particularly painful, massage and manipulation may be undertaken, and a very useful limb result. Where, however, movement is both painful and limited, operative treatment should be undertaken; subcutaneous section of muscles and tendons has been practised, but without much success, and the risk, owing to the fact that the peri-articular structures are displaced and distorted, is so great as to render such a procedure unadvisable. Two chief methods of operative treatment are applicable: (i.) Reduction by an open operation. The head of the bone is cut down on, and freed from its adhesions to surrounding structures, the capsule of the joint being also opened, and the cavity cleared; reduction may then be possible by means of manipulation or extension. A few cases of successful treatment of old-standing dislocations of the shoulder by this means have been recorded; but, as a rule, the gain derived thereby is not commensurate with the risks and difficulties of the operation, especially if a considerable interval has elapsed since the accident. (ii.) Excision of the displaced head of the bone will give the best result in most cases. In the elbow-joint it is often the only practicable treatment, and in the shoulder and hip it is usually better than attempting open reduction.

Compound dislocations are exceedingly serious lesions, inasmuch as not only is the skin lacerated, and the joint exposed to the risk of septic contamination, but also adjacent vessels and nerves are liable to injury. Unless efficient treatment is adopted, suppurative arthritis ensues, leading to disorganization of the articulation with ankylosis, or, in the case of larger joints, possibly to death from pyæmia and septic poisoning. The *treatment* to be adopted consists of the application of the principles of antisepsis already enunciated for the treatment of lacerated wounds, together with reduction of the dislocation. If necessary, the wound in the skin must be enlarged, in order to allow of the replacement of the bone, and, should the latter structure be much bruised or injured, it may be advisable to resect it at once. If, however, vessels and nerves are also injured, or if the patient is old or debilitated, amputation may be required.

Special Dislocations.

Dislocation of the Lower Jaw is not a very common accident, and usually results either from muscular action, or from a blow on the chin when the mouth is widely open, as in gaping, laughing, or attempting to take a large bite. It has also been produced in dentistry by a violent strain during tooth-drawing, or from digging out roots with an elevator. In some persons the accident happens with the greatest ease, and constantly recurs, owing probably to laxity of the capsule, or insufficient development of the eminentia articularis.

The *mechanism* of the dislocation is as follows: When the mouth is opened, the condyle of the jaw slips forwards on to the eminentia articularis, and it requires very little force to displace it anteriorly into the temporal fossa (Fig. 140). The interarticular cartilage follows the condyle, and the attachment of the external pterygoid muscle to that structure explains the occurrence of dislocation owing to muscular action.

The displacement may be unilateral or bilateral, more frequently the latter. The mouth remains widely open, the teeth and the jaws being separated by an interval of about an inch. The lower jaw projects unduly forwards, and is fixed, saliva dribbling over the lip; speech and deglutition are impaired, the pronunciation of the labial consonants being especially difficult. A hollow can be detected immediately in front of the tragus, where the condyle is normally lodged, and in front of this the condyle can be both seen and felt, being readily recognised by the slight amount of passive movement still possible. A finger inserted into the mouth may be able to make out the coronoid process in an abnormal position beneath the zygoma.

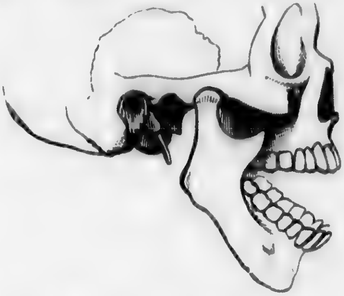


FIG. 140.—DISLOCATION OF JAW.

When the dislocation is unilateral, the symptoms are much less marked. Some amount of movement of the jaw still remains, whilst the chin is displaced laterally towards the sound side.

Treatment.—The reduction of the bone is easily effected. All that is needed is to depress the condyle below the level of the eminentia articularis, when the masseter, temporal and internal pterygoid muscles will speedily draw it back into the glenoid cavity. The patient is seated in a chair; the surgeon standing in front guards his thumbs with a thick napkin to prevent being bitten, and introduces them into the mouth, pressing upon the lower molar teeth. This is continued in a downward and backward direction until the condyle is free, and then the chin is raised by the fingers on either side. The jaw is kept at rest for a few days by means of a four-tailed bandage.

Dislocation of the Sternal End of the Clavicle.—It might be supposed that displacement at this joint would not be uncommon, when the shape and relative sizes of its articular surfaces are considered, together with the great strains to which it is subjected. Owing, however, to the strength of the ligaments surrounding it, particularly of the rhomboid, this is not the case, the clavicle being broken rather than displaced, as the result of force which might be expected to lead to it. The **cause** of such displacements is violence directed to the acromial end of the clavicle. If the force acts from in front, the bone may be thrown forwards; if from above, downwards and inwards, the upward dislocation may occur; if the shoulder is driven forwards and inwards, the head of the bone may pass backwards. Three varieties are described according to whether the head of the bone travels *forwards*, *backwards*, or *upwards*.

In the **forward** dislocation the end of the bone lies on the anterior surface of the manubrium, where it can be easily detected; all the ligaments of the joint are usually torn, except, perhaps, the interclavicular. The point of the shoulder is approximated to the middle line. *Treatment.*—Reduction is easily effected by placing the knee against the spine between the scapulæ, and drawing the shoulders backwards, the elbow on the affected side being kept in front of the mid-axillary line. The displacement is very likely to recur, and to prevent this a pad is kept over the end of the bone by a figure-of-8 bandage, whilst the point of the shoulder is pushed outwards by placing a pad in the axilla, and binding the arm to the side. A hernia truss has also been used by some surgeons to effect this. It is advisable to keep the patient in bed for a few days, so as to give the ligaments a better chance of reuniting, but some amount of forward displacement is very likely to persist. No bad result follows, even should the dislocation remain unreduced.

The **backward** dislocation is not often met with. The head of the bone lies behind the upper part of the sternum, close to the origin of the sterno-hyoid and sterno-thyroid muscles. All the ligaments are ruptured, including the rhomboid. A depression is felt in the usual position of the head of the bone, which may be sometimes detected lying deeply in the superior mediastinum. The shoulder is thrown forwards, and situated nearer the middle line of the body than usual, whilst the movements of the head and neck are painful and limited. Pressure of the bone upon the trachea, œsophagus, and vessels of the neck may give rise to difficulty in breathing and swallowing, whilst the consequent congestion of the head may even cause semi-coma. Reduction by extension of the shoulders backwards is usually accomplished without much trouble. In cases of difficulty, a firm pad can be placed in the axilla, and the shoulder levered outwards by using it as a fulcrum, the elbow being pressed to the side. It is retained in position by keeping the shoulders well extended by the use of two handkerchiefs, as suggested in the treatment of fractured clavicle. If the condition cannot be reduced, and serious symptoms of pressure result, the head of the bone should be excised.

The **upward** dislocation is one of extreme rarity. The head of the bone is felt prominently in front of the trachea, in which situation it may compress both windpipe and œsophagus, especially when the patient sits up or leans forwards. To effect reduction, a pad is placed in the axilla, and the arm pressed inwards over it; the elbow is subsequently bandaged to the side and well elevated.

A pad is at the same time kept over the end of the bone, but it is very probable that some permanent displacement will remain.

Dislocation at the Acromio-clavicular Joint consists in the acromion process of the scapula being forced either above or below the outer end of the clavicle, more commonly the latter. The displacement is easily recognised by the abnormal prominence of one or other of the bones (Fig. 141). It results usually from violence directed to the scapula. No difficulty is experienced in reducing the displacement, but it is very liable to recur, especially in the more common form. The arm should be kept to the side by a pad and bandage. Even if the displacement persists, it is of little importance; but where it gives rise to pain, and leads to impairment of the movements of the arm, it may be cut down on, and the bones wired together after removing the cartilaginous surfaces.

A condition is sometimes met with, described as a **Dislocation of the Lower Angle of the Scapula**. It is characterized by projection of that part of the bone when the arms are thrust forwards. A better name for it is **Winged Scapula**; and it is due rather to paralysis of the serratus magnus and rhomboids than to slipping of the fibres of the latissimus dorsi from the lower angle, as was formerly supposed. In several cases we have noticed pain and tenderness over the roots of the 5th and 6th nerves in the neck, suggesting its dependence on a chronic neuritis of these trunks. A similar condition is sometimes noted in progressive muscular atrophy. The **Treatment** consists in the administration of strychnine, and the use of the faradic current, whilst, if persistent, a properly applied apparatus may correct the deformity.

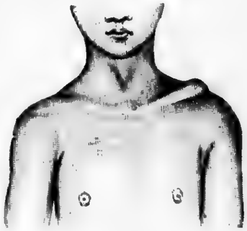


FIG. 141.—DISLOCATION DOWNWARDS OF ACROMIAL END OF CLAVICLE. (TILLMANNS.)

Dislocation of the Shoulder occurs almost as frequently as all the other dislocations of the body put together. The shallowness of the glenoid cavity, the size of the head of the humerus, the laxity of the capsule, the extent and force of the movements possible, and the exposed position of the shoulder, explain the great frequency of the accident. It usually results from falls upon the hand or elbow, the arm at the time of the accident being widely outstretched, to enable the individual if possible to save himself. The lower and inner part of the capsule, its weakest part, receives the chief portion of the shock, and yields, the head of the bone being thus primarily displaced downwards into the axilla (subglenoid variety), and then, according to the direction of the force, or the character of the subsequent manipulations, the head travels either forwards (subcoracoid or subclavicular dislocation) or backwards (subspinous). Falls on the elbow or shoulder may sometimes, however, cause a direct forward or backward displacement.

The **Signs** of a dislocation of the shoulder are sufficiently obvious, and certain characteristic features are met with in almost all varieties. (1) The shoulder looks flattened, owing to displacement of the head inwards, and as a result of this the acromion process is unduly prominent, and a hollow felt below it, occupied by the tense deltoid. (2) The head of the bone lies in some abnormal position, and the glenoid cavity is empty. (3) The elbow is displaced away from the side, and it is impossible to make it touch the chest wall at the same time that the hand is placed on the opposite shoulder (Dugas' test). It must not be relied on, however, especially in the subcoracoid type. (4) The vertical measurement round the axilla is increased in all the varieties (Callaway's test); whilst inspection reveals a lowering of the anterior or posterior axillary fold (Bryant's test). (5) A ruler or straightedge can be made to touch both the acromion process and the outer condyle of the elbow in most cases of dislocation (Hamilton's ruler test); this is impossible when the head of the bone is in its normal position, but can also occur in fractures of the anatomical neck. At the same time, the usual signs of a dislocation already described, viz., rigidity and local bruising, are also present.

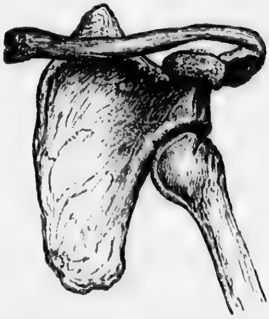


FIG. 142.—SUBGLENOID DISLOCATION OF SHOULDER. (TILLMANNS.)

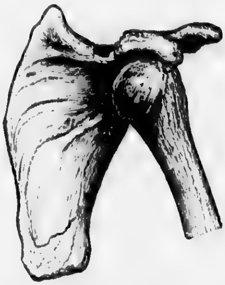


FIG. 143.—SUBCORACOID DISLOCATION OF SHOULDER. (TILLMANNS.)

Subglenoid Dislocation (Fig. 142) is the primary condition met with in all cases where the accident is due to a fall upon the outstretched arm, but is not commonly seen, since the head of the bone usually slips up under the coracoid, as before stated. The head of the bone passes downwards into the axilla, resting against the outer border of the scapula below the glenoid cavity, between the subscapularis above and the teres minor below, whilst the long head of the triceps is placed behind. The capsular ligament and muscles passing to the tuberosities are considerably lacerated, whilst the axillary vessels and nerves may be seriously compressed. The head of the bone is easily detected in the axilla, and the anterior axillary fold is much lowered; the elbow is directed away from the side and slightly backwards; the arm is lengthened, perhaps to the extent of 1 inch, whilst the forearm is usually flexed, and the fingers may be numbed from pressure on the nerves.

A few cases have been recorded in which the arm was abducted and displaced vertically upwards, although the head of the bone was in the usual position of a subglenoid dislocation. This variety is known as the *luxatio erecta*.

Subcoracoid Dislocation (Fig. 143) is, without doubt, the most common form met with. In it the head of the bone lies under the coracoid process on the anterior part of the neck of the scapula, immediately in front of the glenoid cavity, the anatomical neck impinging on its anterior border. In this position it is above the tendon of the subscapularis, which is either torn or stretched over the neck as a tense band, and may considerably impede reduction. Two forms of this displacement are described by Malgaigne, according to whether the muscles attached to the great tuberosity are intact, resulting in marked external rotation of the limb (subcoracoid variety), or whether they are lacerated, or even the great tuberosity itself pulled off, the humerus being then rotated inwards (intracoracoid variety). In both types the elbow is displaced backwards and outwards, and the head of the bone can be usually felt with ease, especially on rotation of the arm, under the outer third of the clavicle, except in stout people or where the muscles are greatly developed. Comparatively little alteration in the length of the arm is produced.

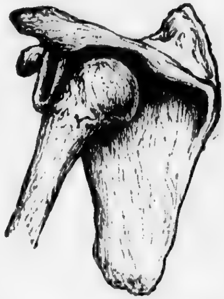


FIG. 144.—SUBSPINOUS DISLOCATION OF SHOULDER. (TILLMANNS.)

In the **Subclavicular** variety, which is very uncommon, the head of the bone passes further inwards than in the subcoracoid form, and is merely an exaggeration of that displacement. The head lies deeply under the pectoralis major, on the second and third ribs. The capsule and surrounding muscles are much lacerated, or perhaps the great tuberosity torn off; the elbow is markedly separated from the side and directed a little backwards, whilst distinct shortening is present.

The **Subspinous Dislocation** (Fig. 144) is not frequently met with. The head of the bone lies in the infraspinous fossa, immediately behind the glenoid cavity, between the infraspinatus and teres minor muscles, the subscapularis being usually torn. Malgaigne states that the head of the humerus is most commonly found resting on the posterior edge of the glenoid cavity immediately below the acromion process (subacromial variety). The elbow is displaced considerably forwards, but can be made to touch the chest wall; the arm is rotated inwards, so that the hand is thrown across the front of the body. There is usually a marked hollow beneath the coracoid process, whilst a distinct prominence is caused by the head of the bone in its false position. The length of the limb is frequently unaffected, or if any change is present, the arm is slightly lengthened.

Three or four cases have been described of what is known as a **Supracoracoid Dislocation.** The head of the bone is here displaced upwards, and either the coracoid or acromion process is broken, more commonly the former. Replacement with crepitus is easily obtained, but the dislocation readily recurs.

The **Treatment of Dislocation of the Shoulder** consists in reduction by manipulation or extension.

1. For *reduction by manipulation* an anæsthetic is advisable, though not absolutely essential, and preferably chloroform, although where the patient is in a bad state for the administration, *i.e.*, with his stomach full of food, ether may be preferable. It is only right to draw attention to the fact that a large number of fatal cases of chloroform administration have been reported as occurring in the treatment of shoulder dislocations; this is due mainly to two causes, viz., the deep anæsthesia required, and the want of preparation of the patient. The greatest care must therefore be exercised in giving the anæsthetic. Many different methods have been suggested, of which the following are the more important. Not unfrequently, where the muscles are relaxed, any slight rotary movement suffices to 'put the bone in.'

Kocher's Method.—The surgeon standing in front of his patient, who is seated, or reclining, grasps the elbow after flexion of the forearm, and presses it to the side. The arm is now rotated firmly and steadily outwards until it is at right angles to the body, when distinct resistance will be felt. This causes the head of the humerus to roll out beneath the acromion, and is often sufficient to effect reduction; but if the limb is still displaced, the elbow should be drawn forwards to the median line, with the hand still abducted and everted, whilst finally the arm is rotated inwards so as to carry the hand towards the opposite shoulder, and the elbow lowered. This plan is most useful in subcoracoid dislocations.

Smith's Method varies somewhat in its application, according to whether the head of the bone is displaced anteriorly or posteriorly. For anterior displacements the surgeon stands in front of the patient, and grasps the shoulder, using the right hand for the right shoulder and the left for the left, so that the thumb rests on the head of the bone, and the fingers grasp and steady the scapula. With the other hand he seizes the arm near the elbow which has been flexed, and raises it from the side, extending and everting it. Having thus raised it to a right angle, the limb is steadily and continuously circumducted inwards, the thumb following the head of the bone and assisting it to reach the lower and under side of the capsule, and thus enter the socket through the rent. For the subspinous dislocation, the surgeon stands behind the patient and grasps the shoulder with one hand, raising the arm with the other, and making extension backwards combined with external rotation; *i.e.*, the limb is circumducted outwards, and finally brought to the side.

2. *Extension* may be made in different ways, the object of all, however, being to overcome the tension of surrounding ligaments and muscles. It may be applied directly downwards by the surgeon grasping and pulling on the arm, whilst his unbooted foot is used as a counter-extending force in the axilla, the patient lying flat on a mattress placed on the ground, and the surgeon sitting by the side. Another plan consists in using the knee as a fulcrum instead of the heel, the patient sitting in a chair. Occasionally the foot has been placed against the thoracic wall, and extension made directly outwards at right angles to the body, as recommended by Sir Astley Cooper. White of Manchester suggests vertical traction, the arm being pulled directly upwards, the surgeon's foot having been placed over the acromion, the patient being in the recumbent posture. The only objection to this last method, which may succeed where other plans fail, is that the axillary vessels are somewhat exposed to injury.

Dislocations of the Elbow-Joint are not very uncommon, occurring particularly in children, and then perhaps associated with some epiphyseal lesion. They are due to either direct or indirect violence. They always result in great swelling and ecchymosis of the surrounding tissues, causing their real nature to be obscured, and the diagnosis is hence often difficult. A careful investigation of the relative position of the bony points (p. 392), and of the power of mobility of the different parts on each other, is essential in order to come to a definite conclusion as to the exact nature of the lesion. In cases of doubt, a skiagram should, if possible, be taken.

A considerable variety of displacements is met with, involving either one or both bones.

1. **Dislocation of Both Bones** may occur either *backwards*, *forwards*, or *laterally*.

The **backward** variety (Fig. 112A) is that most often met with; it usually occurs without either the coronoid process or the olecranon being fractured, although occasionally the former is detached. If the coronoid remains intact, it sometimes becomes impacted in the olecranon fossa, and renders the arm immobile; if, however, it is broken, considerable mobility of both bones occurs, with crepitus. The forearm is semi-flexed, the hand held midway between pronation and supination, and the displaced bones form a considerable swelling at the back of the joint, above which is a marked hollow, crossed by the triceps tendon. The lower end of the humerus projects in front, and the artery and the soft parts are displaced forwards. The measurement from the acromion process to the external condyle remains unaltered, but that from the condyle to the styloid process of the radius is distinctly shortened.

Dislocation **forwards** of both bones hardly ever occurs without fracture of the olecranon process, although a few cases of this unusual accident are on record. The displacement is readily detected, the forearm being lengthened perhaps to the extent of an inch. The arm is in a condition of flexion, and, indeed, the accident can only possibly occur from falling backwards on the point of the elbow when in this position. The triceps muscle may be considerably lacerated.

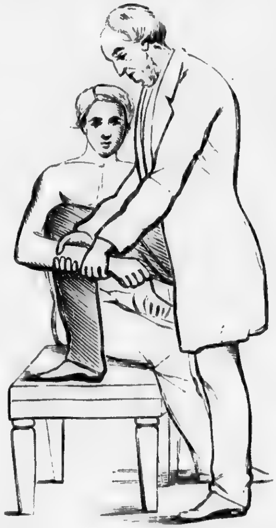


FIG. 145.—REDUCTION OF BACKWARD DISLOCATIONS OF THE ELBOW.

Lateral dislocations of the forearm are almost always incomplete and are not very frequent; the bones may be displaced either inwards or outwards, the latter being the more common. They can only be recognised by a careful examination of the relative position of the bony prominences.

2. **Dislocation of the Ulna alone** occurs only in a *backward* direction. It is an occurrence of the greatest rarity, necessitating rupture of the orbicular ligament, and usually also of the oblique ligament and the interosseous membrane.

The **Treatment** of the above dislocations is carried out along the same lines, all that is necessary being to unhitch the interlocking bony prominences, so as to allow the bones to return to their normal positions by muscular contraction. This is usually accomplished by the method described originally by Sir Astley Cooper. The patient being in a sitting position, the surgeon presses backwards, with his knee in the bend of the elbow, against the lower end of the humerus; at the same time he grasps the patient's wrist, and slowly and forcibly bends the forearm (Fig. 145).

3. **Dislocations of the Radius alone** may occur either *forwards*, *backwards*, or *outwards*.

The **forward** dislocation (Fig. 146) is that usually seen, and results from falls on the hand when the forearm is in a state of extreme pronation. The head of the bone rests against the lower end of the humerus in the hollow above the capitellum, and the most characteristic feature consists in the inability of the patient to flex his forearm, owing to the head of the bone impinging against the lower end of the humerus. It can be readily detected in this situation, rotating with the movements of the forearm, whilst a deep hollow is left behind, immediately below the external condyle. The forearm is somewhat flexed, and midway between pronation and supination; the former act can be fully accomplished, but supination cannot be carried further than half-way. A marked fulness exists on the anterior aspect of the limb when the arm is fully extended. It is stated by some surgeons that fracture of the upper third of the ulna usually accompanies this accident, especially when produced by direct violence; but this is more than doubtful. If this luxation is not reduced, very great impairment of the mobility of the limb will result, flexion beyond an obtuse angle becoming impossible.

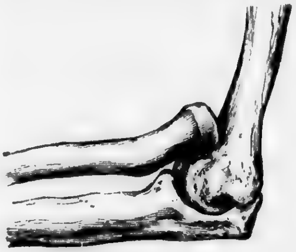


FIG. 146.—DISLOCATION OF THE RADIUS FORWARDS. (PICK.)

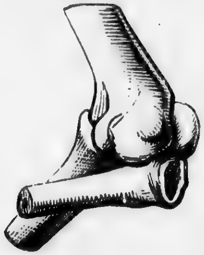


FIG. 147.—DISLOCATION OF THE RADIUS BACKWARDS.

Treatment.—Reduction is accomplished by extension from the wrist, with the forearm flexed to a right angle, combined with pressure over the head of the bone. Owing to the fact that the orbicular ligament is ruptured, the deformity is very likely to recur, and hence active movements of the limb must be interdicted for three or four weeks; a pad may be placed anteriorly over the head of the bone, and the limb kept flexed on a splint.

Dislocation **backwards** is less common. The head lies behind the external condyle on the outer side of the olecranon, where it can be detected on rotating the limb (Fig. 147). The forearm is flexed, and the limb pronated. Even if left unreduced, it leads to but little inconvenience.

Dislocation **outwards** is also rare, the head of the bone being displaced to the outer side of the external condyle, where it can easily be felt, causing considerable impairment of the natural movements. Reduction of these conditions is accomplished without difficulty.

Occasionally a rare form of dislocation is met with in which the ulna passes backwards and the radius forwards, resulting in great deformity. The nature of the accident is easily recognised on examination.

A very common accident in children consists really of a **subluxation of the head of the radius downwards** within the orbicular ligament, so that a portion of it slips up and becomes nipped between the head and capitellum. It results from forcible traction of the hand, and is a common nursery accident, popularly known as **pulled elbow**. The limb becomes fixed in a position of semi-flexion, and the child cries out with the pain; it is readily treated by completely flexing the limb, and subsequently extending it, and leaves no bad results.

It must not be forgotten that we have here merely described the pure dislocations. In actual practice **complications** of a serious nature are frequently present in the shape of fracture of one or both condyles, which lead to much difficulty in diagnosis. These fracture-dislocations give rise to so much hæmorrhage that it is frequently impossible to come to a correct conclusion as to the nature of the case. The Röntgen rays will assist materially in the future; but it is doubtful whether even an accurate knowledge of the nature and extent of the lesion will enable us to improve on the results hitherto gained apart from operation. So much callus is likely to be formed, and fibrous adhesions of such strength are often developed, that considerable impairment of function is almost certain to ensue. Probably the best line of practice to follow is to keep the elbow at rest on a rectangular splint for a week or ten days, so as to allow the immediate effects of the accident to pass off, and then to make an aseptic incision, dealing with the condition of affairs in the way best suited to the requirements of the particular case.

Dislocation of the Wrist is a very uncommon accident, and may occur *forwards* or *backwards*. The lower ends of the radius and ulna become prominent under the skin, and the styloid processes especially noticeable. By this means it is easily distinguished from a fracture of the lower ends of the bones.

Occasionally the radius, carrying with it the hand, is dislocated from the lower end of the ulna, which projects backwards on forcible pronation. All such displacements are easily reduced.

Dislocations of various Carpal Bones have been described, but the only one which is at all common is a displacement of the os magnum backwards. It forms a rounded prominence under the skin in the usual situation of the bone, which becomes more prominent on flexion, and may disappear on extension. As a rule, it is readily reduced, but is very likely to recur.

Dislocations of the Metacarpal Bones and Phalanges are not unfrequent, but need no special mention, except in the case of **Dislocation Backwards of the First Phalanx of the Thumb.** In this affection the head of the metacarpal bone slips forwards between the two heads of the flexor brevis pollicis, which grasp it tightly, so that it projects as a button through a buttonhole (Fig. 148). Treatment is a matter of considerable difficulty, owing to the fact that traction on the thumb narrows the space between the tendons, and thus impedes rather than assists reduction. To attain this end, the thumb must be grasped by some special apparatus, and hyperextended to a right angle, so as to cause the mushroom-shaped head of the metacarpal bone to project to a greater degree between the heads of the flexor brevis, thus enlarging the 'buttonhole.' Still keeping up the extension, it is then rapidly flexed into the palm, the metacarpal bone being at the same time pressed inwards. Should this manœuvre fail, it is necessary to divide, by an open or subcutaneous operation, some of the fibres which grasp the bone.

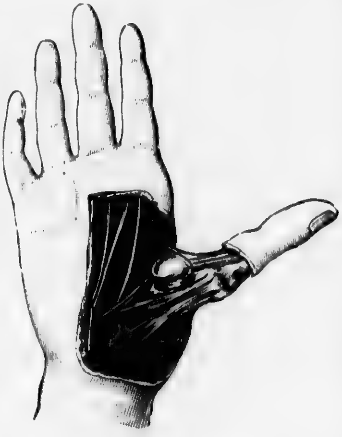


FIG. 148.—DISLOCATION OF THUMB, SHOWING HEAD OF THE METACARPAL BONE PROTRUDING FORWARDS BETWEEN THE HEADS OF THE SHORT FLEXOR MUSCLE. (PICK.)

Dislocation of the Hip, though not exceedingly common, is a condition of extreme gravity. The depth of the socket in which the femur rests, and the strength of the muscles and ligaments surrounding the articulation, explain the comparative infrequency of the accident. It is never produced by direct violence, but always results from a force applied to the feet or knees, or, if the legs be fixed, to the back. It is rarely met with except in young people or adults, since after the age of forty-five fractures of the neck of the bone are much more likely to occur.

In considering these dislocations, the relative strength or weakness of the different parts of the capsule and its surrounding structures must be remembered. Thus, the weakest part of the capsule is placed below and behind, and the fibres here are easily lacerated; indeed, it is through a rent in this part of the capsule that the head of the bone most frequently escapes from the articulation. In front, the ilio-femoral or Y-shaped ligament of Bigelow, extending from the anterior inferior iliac spine to the anterior intertrochanteric line, is a structure of much strength, and on the integrity of which depends the fact whether the displaced head of the bone shall occupy some definite position or be freely moveable. Hence Bigelow, to whom we owe so much in the elucidation of the mechanism of these dislocations, has divided them into two great classes—the *regular* and the *irregular*—according to whether this ligament is intact or completely lacerated. Posteriorly, the tendon of the obturator internus muscle, consisting of a mass of plicated tendinous tissue, is the most important structure to be considered, and according to whether it is ruptured or not depends in some measure the position and level of the bone on the dorsum ilii. It must also be remembered that the ligamentum teres is relaxed when the thigh is forcibly abducted, and is made tense by adduction.

Four chief varieties of dislocation are described, in two of which the head of the bone is displaced posteriorly, and in two anteriorly. The two former are known as the *Dorsal* and the *Sciatic* varieties, although *Dorsal below the tendon*, as originally suggested by Sir Astley Cooper, is the better appellation for the latter variety. The two anterior dislocations are known as the *Obturator* or *Thyroid*, and the *Pubic*; in the former cases the head of the bone is located in the obturator notch, and in the latter upon the pubic ramus. The relative frequency of these dislocations is as follows: About 50 to 55 per cent. of the cases are of the dorsal type, 20 to 25 per cent. sciatic, 10 to 15 per cent. obturator, and 5 to 10 per cent. pubic. In addition to these four varieties, many other slight modifications have been described, which it will be unnecessary to further particularize.

The exact **Mechanism** of dislocations of the hip is still more or less a matter open to discussion. Many surgeons maintain the opinion strongly held by Mr. Henry Morris—that the limb is always in a position of abduction at the moment of dislocation, the head of the bone escaping from the capsule through a rent [illegible] the lower and back part of the ligament, and thus being primarily displaced downwards. The type of accident responsible for this is when the patient falls with the legs widely separated, or when the limbs are drawn forcibly apart, as, for instance, when one [illegible] is placed on a boat just moving away from a pier on which the other is fixed. The direction of the violence, or the subsequent manipulations performed by willing but ignorant friends, or the voluntary movements of the individual, will determine what form of dislocation is to be subsequently produced. If the limb is externally rotated and extended, the head travels forwards, and either the pubic or obturator variety results. If, however, the leg is inverted and flexed, the head of the bone passes backwards, and either the dorsal or sciatic form is produced. If the obturator internus tendon remains intact, it may hitch across the front of the neck, and prevent any further upward displacement of the bone, thus giving rise to the so-called sciatic variety; but if the tendon is ruptured, or if the head of the bone slips in front of it, there is no obstacle to its displacement on to the dorsum ilii.

Bigelow, however, and with him many other surgeons, maintain that dislocation of the hip does not only occur with the limb in a position of abduction. Under certain circumstances, it may also result when the limb is in a position of adduction, a *direct dorsal dislocation* being thus produced, the head of the bone escaping from the capsule above the tendon of the obturator internus; such an accident is sometimes, but not always, associated with fracture of the posterior lip of the acetabulum. The type of violence leading to this occurrence is when a heavy weight falls on the back of a person whilst kneeling, or when, his knee being fixed, the body is thrust forwards, so that the limb becomes forcibly inverted. If, however, the limb is in a position of extreme flexion, the head may be displaced below the tendon of the obturator internus, and the sciatic variety will then result.

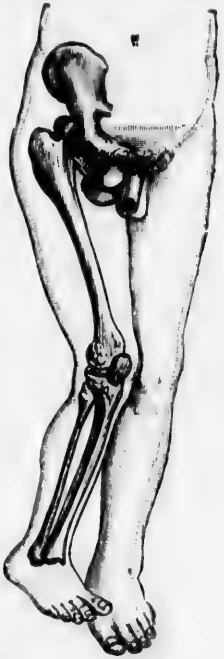


FIG. 149.—DORSAL DISLOCATION OF THE HIP. (TILLMANNS.)

1. **Dorsal Dislocation** (Fig. 149).—The head of the bone in this form is found lying on the dorsum ilii, a variable distance above and behind the acetabulum, and always above the obturator internus tendon. It may be detected on manipulation of the limb, although in muscular subjects this is difficult. The ligamentum teres is necessarily ruptured, as also the capsule, the rent being situated either below or above the obturator tendon according to whether the dislocation is due to forcible abduction or adduction. The small external rotator muscles are usually lacerated, and perhaps even the glutei and the pectineus. The ilio-femoral ligament usually remains intact. The great sciatic nerve is sometimes com-

pressed or contused. The trochanter is raised above Nélaton's line (p. 408), and approximated to the anterior superior spine; the ilio-tibial band of fascia is therefore relaxed. There is considerable shortening of the limb, amounting often to 2 or 3 inches, and this cannot be remedied by moderate traction, as sometimes occurs in cases of fracture. The leg is in a position of flexion, adduction, and inversion, so that the axis of the femur crosses the lower third of the sound thigh. The knee is semi-flexed, and the ball of the great toe rests against the opposite instep; the heel is somewhat raised. A marked hollow is felt in the upper part of Scarpa's triangle, and the main vessels of the limb appear to be unsupported.

The **Diagnosis** should be easy, the only difficulty being experienced in distinguishing it from an impacted extra-capsular fracture. The character of the accident, the presence of adduction and inversion, the increased breadth of the trochanter in the case of fracture, and the abnormally placed head of the bone in dislocation, are the points on which importance must be placed in making a diagnosis.

2. **Sciatic Dislocation**, or dorsal below the tendon, is one in which the head of the bone is prevented from travelling upwards to the dorsum ilii by the integrity of the obturator internus tendon, as already described. It may occur either from forced abduction of the limb, or from extreme flexion in the adducted position. The lesions of muscles and ligaments are practically the same as for the dorsal variety. The ilio-femoral ligament is uninjured.

The **Signs** resemble those of a dorsal dislocation, but are less marked. There is less shortening, often not more than ½ to 1 inch; the limb is flexed, adducted, and inverted, but the axis of the femur is directed across the opposite knee, and the great toe rests against the ball of the great toe of the opposite side. The head of the bone is often much less distinct, owing to the greater thickness of the glutei muscles at that level.

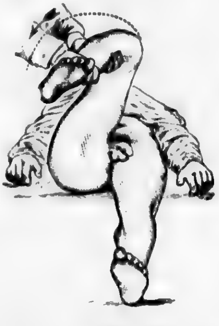


FIG. 150.—REDUCTION OF DORSAL DISLOCATION OF HIP. (BRYANT.)

Treatment of the Two Backward Dislocations is effected in much the same way, whether the dorsal or sciatic variety is present. The most usual method is that of *manipulation and rotation*, so accurately worked out by Bigelow. The patient is anæsthetized, preferably on a mattress placed on the floor. The leg is first flexed on the thigh, and the thigh on the abdomen, the position of adduction being still maintained, so that the knee extends beyond the middle line of the body (Fig. 150). This position is maintained for some moments with energy, and then the limb is freely circumducted outwards, and brought rapidly down into a position of extension parallel with the other. By this manœuvre the tense structures in front of the joint are relaxed, and then the head of the bone is made to retrace its course towards the rent in the capsule, and finally directed upwards into the acetabular cavity. These movements are tersely summarized in Bigelow's words—'*Lift up, bend out, roll out.*'

If this plan does not succeed, the following method of *traction* may be employed. The patient, lying on his back, is firmly fixed by a bandage or towel passed over the pelvis and secured to two or three hooks or staples driven into the floor. The surgeon stands over the patient, whose thigh is flexed to a right angle on the abdomen, as also the knee upon the thigh. The surgeon's arms are passed under the knee sufficiently far to enable him to grasp his own elbows, and the front of the leg is steadied against the operator's perineum. Direct and forcible traction upwards can now be made, and this is often sufficient in itself to lift the head of the bone into the acetabulum. If this is unsuccessful, the movements described above can be energetically repeated in this position. The above plans, combined with the use of an anæsthetic, rarely fail in reducing a backward dislocation of the hip, and hence *extension by means of pulleys* is rarely called for. If, however, it is needed, traction should always be made in the direction of the displaced limb, *i.e.*, across the other thigh, counter-extension being obtained by a jack-towel passed between the injured thigh and the perineum, and fixed to a staple in the floor, close to the head of the patient, and on the side of the dislocation. When sufficient force has been applied, the surgeon rotates the limb outwards, so as to allow the head of the bone to once more slip into its socket.

3. **Thyroid or Obturator Dislocation** (Fig. 151).—The head of the bone in this case passes downwards through a rent in the lower part of the capsule, and its position is subsequently but little altered, a slight forward and upward movement being alone superadded. The ilio-femoral ligament is untorn, but the pectineus and adductors are very tense, or may even be lacerated; the ligamentum teres is, of course, ruptured. The head lies on the obturator externus muscle, and can sometimes be readily detected in the perineum. The trochanter is less prominent than usual, and, indeed, its normal position may be represented by a depression. The limb is slightly abducted and everted, as well as lengthened, perhaps to the extent of 2 inches, though this is more apparent than real. It is also flexed, owing to the tension of the ilio-psoas muscle, and advanced before the other, and with the toes pointing outwards. The adductor longus tendon stands out prominently, and much pain may be experienced from pressure on the obturator nerve. If the patient stands, the body is bent forwards, whilst it is interesting to note that if the dislocation remains unreduced the patient may be able to walk without much pain or inconvenience, though in a more or less stooping position.

4. **Pubic Dislocation** (Fig. 152).—In this variety the head of the bone lies on the horizontal ramus of the pubes, just internal to the anterior inferior spinous process of the ilium, where it can be felt rolling under the finger on any movement of the limb. The vessels are pushed inwards, and considerable pain may be felt down the limb from pressure on the anterior crural nerve. The ilio-femoral ligament is untorn, whilst the ligamentum teres and capsular ligament are ruptured; the small external rotator muscles, with the exception of the obturator internus, are usually torn. There is marked flattening of the hip, the trochanter being approximated to the middle line and raised. The limb is shortened to the extent of 1 inch, and there is considerable abduction and eversion, so that the inner aspect of the limb looks forwards. The thigh is slightly flexed to relax the ilio-psoas muscle.

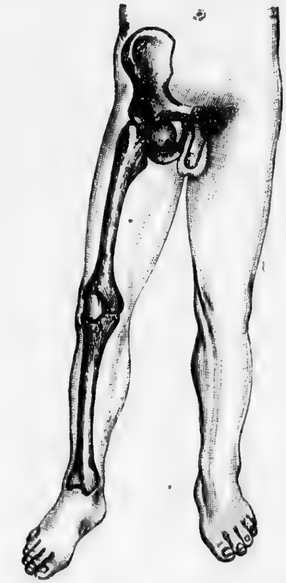


FIG. 151.—DISLOCATION OF THE HIP: OBTURATOR VARIETY. (TILLMANNS.)

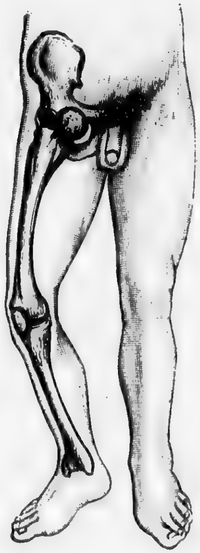


FIG. 152.—DISLOCATION OF THE HIP FORWARDS: PUBIC VARIETY. (TILLMANNS.)

Treatment of the thyroid and pubic dislocations is undertaken along similar lines as for the posterior dislocations. The patient is anæsthetized; the knee is flexed, as also the thigh upon the abdomen, but in a position of abduction; circumduction inwards follows (Fig. 153), and on extension of the limb the head again enters the acetabulum. The thyroid variety may sometimes be reduced by simple upward traction when the limb has been flexed to a right angle in the abducted position, the unbooted foot being placed against the pelvis to steady it.

If extension by pulleys is required in the thyroid dislocation, it is made transversely across the upper part of the thigh, counter-extension being obtained by means of a band passed round the abdomen. The limb, at first in a position of abduction, is subsequently forcibly adducted by drawing the ankle inwards, the band by means of which extension is being made acting as a fulcrum to lever the head of the bone into the acetabulum. In the pubic variety traction is made downwards, outwards, and backwards, and the head of the bone drawn into its socket by a towel passed transversely across the limb.

After reduction of any form of dislocation of the hip, the patient should be kept in bed with the legs tied together for about a fortnight, and then passive movement may be commenced, but with considerable caution; voluntary movements should not be undertaken for another week or two.

Should the dislocation recur, it may be due to fracture of the posterior lip of the acetabulum, or to some involuntary movements of the patient, or perhaps to the fact that the displacement has not been fully reduced. Under such circumstances further attempts at replacement should be undertaken, and subsequently the limb must be kept immobilized for a longer period than usual.

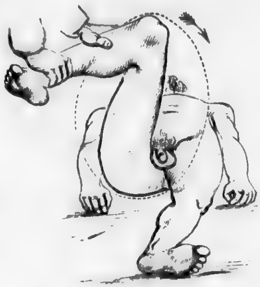


FIG. 153.—REDUCTION OF ANTERIOR DISLOCATIONS OF THE HIP. (BRYANT.)

Other irregular dislocations of the hip are met with, where the Y-shaped ligament is completely torn through, so that the head of the bone is not restricted, but can be moved round the acetabular cavity. Reduction is usually easy.

Dislocation of the Patella may occur *outwards*, *inwards*, or *edgeways*. A dislocation upwards resulting from rupture of the ligamentum patellæ is sometimes described, but it is scarcely to be included in the same category as the others. The displacement may be complete or incomplete; in the former the capsule is always lacerated; in the latter, not necessarily so.

The **outward** variety is much the commonest on account of the obliquity of the limb, and may result from muscular action, especially in people suffering from genu valgum; it also arises from direct violence. In either case it occurs most commonly when the limb is extended, since during flexion the bone is more firmly lodged in the intercondyloid notch. When completely displaced, it lies upon the outer surface of the condyle, with its inner margin projecting forwards. In this situation it is easily felt, whilst the knee appears flattened and broader than usual, the intercondyloid notch being plainly distinguishable in the position usually occupied by the patella. It is not unfrequently, however, incomplete, and then the inner half of the articular surface of the patella lies in contact with the cartilaginous surface of the outer condyle, with its outer border projecting forwards. *Reduction* may take place spontaneously, but is usually effected by manipulation. The thigh is flexed on the abdomen, and the knee extended, so as to relax the quadriceps, and then, with a little pressure on its outer margin, the bone slips back into place. In the incomplete form where one of the borders of the bone is lodged in the intercondyloid notch, reduction is sometimes very difficult, and to effect it an open operation may be required.

The **inward** dislocation is exceedingly rare, being always due to direct violence. In characters and treatment it is the exact converse of those met with when the bone is displaced outwards.

A dislocation edgeways, or **Vertical Rotation** of the patella, is an interesting condition in which the bone is said to be twisted vertically upon its own axis, and even to have been turned completely round. The incomplete rotation is practically identical with that just described as an incomplete lateral dislocation, whilst the complete rotation of the patella must indeed be a rare accident.

Dislocations of the Knee may occur *laterally*, as also *forwards or backwards*. When due to disease of the joint, the backward dislocation is commonest; but when arising from traumatic causes, the lateral is the most frequent.

The **lateral** displacements are rarely complete, and are usually associated with a certain amount of rotation; the leg is partially flexed. Reduction is effected without difficulty.

Dislocation of the tibia **forwards** is more common than displacement backwards. It is frequently complete, the lower end of the femur projecting into the popliteal space, and compressing the vessels. The upper end of the tibia, carrying with it the patella, lies in front, forming a well-marked swelling with a hollow above it. There is usually considerable shortening of the limb if the articular surfaces overlap.

Dislocation of the tibia **backwards** is a much less common accident, and is more frequently incomplete than the former. The signs are exceedingly characteristic, the pressure effects upon the popliteal vessels and nerves being less pronounced than in the former case.

Reduction of either of these conditions is easily accomplished by traction on the limb, whilst the thigh is flexed, combined with manipulation in order to guide the head of the tibia into its normal position. The limb must subsequently be kept at rest in splints for two or three weeks.

Displacement of a Semilunar Cartilage (*syn.: subluxation of the knee, internal derangement of the knee-joint*) is a condition frequently met with, resulting from sprains and strains of the joint. In any rotary movement of the knee, which, however, can only be undertaken when the limb is flexed, the pressure of the condyles always tends to modify the position of the cartilages; moreover, with the limb in a state of flexion, they are relaxed and more freely moveable on the upper surface of the tibia than in extension. Any sudden strain or wrench, *e.g.*, turning quickly round in such games as tennis, or slipping off the kerbstone with the knee bent, may lead to this accident. The internal cartilage is much more frequently affected than the external. The displacement itself varies in character; sometimes the coronary ligaments give way, allowing the cartilage to slip outwards from between the bones, or inwards into the joint cavity; occasionally the anterior attachments may give way, and the cartilage doubles over backwards on itself; whilst in other cases it may be folded over on itself inwards, and may then fit into the intercondyloid notch. In other cases the cartilage splits either diagonally or concentrically, and thus becomes thinned and enlarged.

The **Symptoms** produced by this accident are a sudden sickening pain of much severity, located in the knee, which becomes partially locked in a position of flexion, with inability to extend. The patient may be able to 'wriggle' his joint free, or the limb may remain stiff for some hours, or even a day or two, when movement suddenly returns more or less spontaneously, a snap being at the same time felt within the joint. An attack of subacute synovitis usually follows. In other cases the cartilage remains out of place, until reduced by the surgeon, with or without an anæsthetic. If the case is not carefully treated, the displacement is liable to recur, the cartilage constantly slipping in and out, getting nipped between the bones; as time goes on, this becomes more and more easy, owing to the ligaments of the joint becoming relaxed from the recurrent attacks of synovitis. In fact, the limb may pass into such a state of chronic weakness as to seriously interfere with the patient's comfort.

In the early stages it may be possible to feel, or even see, the projection caused by a cartilage which has been protruded from between the bones; whilst if the displacement has been inwards towards the joint cavity, a gap may be felt corresponding to its usual situation. In the later stages, when the cartilage is loose, no physical changes can as a rule be detected between the attacks, but there is usually a spot of localized pain in the front of the joint, corresponding to the upper surface of the tibia, and possibly there may be some amount of lateral mobility of the leg, and even movement of the cartilage may be detected on flexing the knee.

The **Treatment** in the early stages consists in replacement of the cartilage by manipulation. The limb is fully flexed and then suddenly extended, pressure being applied at the same time in the neighbourhood of the displaced cartilage, which often returns into position with a distinct snap. The limb is subsequently kept at rest on a back-splint, and cooling lotions applied until the inflammation has subsided, and then is further immobilized for some weeks in plaster of Paris or water-glass, so as to allow the lacerated ligaments to reunite and consolidate. At the expiration of six or eight weeks after the accident an elastic knee-cap is applied, and the patient again allowed to move the joint.

Where the cartilage has become loose and is constantly slipping out of place, immobilization of the limb, with pressure over the painful spot by an elastic knee-clip, as recommended by Mr. Howard Marsh, may be useful. Should this not prove satisfactory, operative proceedings must be undertaken.

The knee-joint is opened by an incision on the appropriate side of the patella, more or less transverse in direction, and the condition of the cartilage ascertained. If of normal shape and merely loose and moveable, it may be readily stitched to the periosteum over the head of the tibia, so as to keep it from again slipping between the bones; this is perhaps best accomplished by splitting the cartilage diagonally into two portions, and securing each of these by two or three catgut stitches. If, however, it is doubled on itself, or deformed, and if it seems impracticable to efficiently fix it, it may be removed; it is astonishing how well patients get on after such an operation. The greatest care must be taken to maintain asepsis, and no strong or irritating antiseptic must be allowed access to the joint cavity, which is closed by a series of buried sutures, dealing in order with the synovial membrane, the capsule, the superjacent tendinous tissues, and, finally, the skin. It is advisable to drain the joint for twenty-four to forty-eight hours, and, as an additional precaution against infection, it may be well to immunize the patient by preparatory injections of antistreptococcic serum.

Dislocations of the Ankle-joint may occur in the following directions: *outwards*, *inwards*, *backwards*, *forwards*, and *upwards*, this being the order of their frequency. Owing to the fact that the head of the astragalus is wedged like a block into the cavity formed by the lower ends of the tibia and fibula, it can be readily appreciated that fractures of these bones are frequently met with as complications.

The **lateral** dislocations are in reality fracture-dislocations, and have been already described in the chapter on fractures (p. 424).

Although the articular surface of the astragalus is broader in front than behind, dislocation of the foot **backwards** is a more common accident than displacement forwards. It results from falls on the feet whilst running or jumping, or by sudden violence applied to the limb when the foot is fixed. One or both malleoli are always fractured, and the articular surface of the astragalus is thrown behind the lower end of the tibia. The heel projects unduly backwards and the lower end of the tibia usually rests upon the neck of the astragalus, the scaphoid, or even the cuneiform bones.

Dislocation **forwards** is very uncommon, and may occur without any associated fracture of the bones of the leg. The foot is apparently lengthened, and the tibia rests upon the posterior part of the upper surface of the os calcis, behind the astragalus. The prominence of the heel and of the tendo Achillis is lost, and the normal depression in front of the latter structure is occupied by the lower ends of the bones of the leg.

The *treatment* of antero-posterior dislocations consists in reduction by traction. The leg is flexed upon the thigh, so as to relax the tendo Achillis, and, if necessary, this structure may be subcutaneously divided. Once replaced, the joint is put up in a pair of Cline's side-splints, care being taken to ascertain that the foot is at right angles to the leg, and that the articular surfaces of the astragalus and tibia are exactly in apposition, thus preventing any displacement of the heel backwards or forwards. A Roughton's splint—*i.e.*, an external splint with a sole-piece—may also be used with advantage.

A dislocation **upwards** has been described in which the astragalus, together with the foot, is carried up between the tibia and fibula. To allow of such, the inferior tibio-fibular ligament and the lower end of the interosseus ligament must have been ruptured. Impracticable as such an accident appears, competent observers maintain that they have met with it. The displacement is very marked, and the character of the lesion very evident.

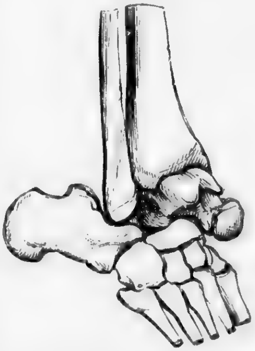


Fig. 154.—Dislocation of the Astragalus Forwards.

Dislocations of the Astragalus alone are by no means common, although their distinguishing features are well recognised. They consist in a partial or complete detachment of the bone from all its normal connections, both to the bones of the leg and of the foot, and its displacement from under the tibio-fibular arch. It may travel *backwards* or *forwards* with or without lateral rotation.

Dislocation **forwards** (Fig. 154) is much the more common variety, although it is usually associated with partial rotation, the displacement occurring more frequently outwards than inwards. When complete, the bone is entirely detached from its connections with the os calcis, scaphoid, and bones of the leg, and lies upon the upper surface of the scaphoid and cuneiform bones, tensely stretching the skin of the dorsum of the foot over it, or even perhaps bursting it. The limb becomes shortened, and the malleoli approximated to the sole.

In the incomplete variety, the head of the astragalus rests either upon the scaphoid on the inner side, or the cuboid on the outer. The lower end of the tibia rests on the posterior half of the articular surface, whilst when the displacement is complete it lies on the upper surface of the os calcis.

Dislocation **backwards** is almost always complete, and may or may not be associated with rotation of the bone, which can easily be felt between the tendo Achillis and the malleoli.

Treatment.—Reduction is only possible in the incomplete forms of dislocation. Manipulation after relaxation of the muscles by position, or a subcutaneous division of the tendo Achillis, may be successful. The patient is anæsthetized, the knee flexed, and traction upon the foot established, so as to enable the surgeon to apply pressure in a suitable direction. In the complete form of dislocation, it is usually impracticable to accomplish reduction, owing to the fact that the os calcis is drawn up into contact with the malleolar arch. In such cases manipulation is useless, and excision of the bone is the best method to adopt. Comparatively little impairment in the function of the foot results from this operation.

Subastragaloid Dislocation.—By this term is meant a displacement of all the bones of the foot from below the astragalus, which retains its normal position between the malleoli. The interosseous and other ligaments passing from the astragalus and malleoli to the tarsal bones are necessarily ruptured. The cause of this, as of other dislocations in the neighbourhood, is some violent strain or wrench of the foot.

Displacement of the foot may occur either forwards or backwards, but in the great majority of cases it is either *backwards and inwards* or *backwards and outwards*. The luxation is rarely complete as regards the calcaneo-astragaloid joint, but the articular surfaces of the head of the astragalus and scaphoid are completely separated, the former structure lying on the dorsal surface of the latter bone. The foot is greatly deformed, the anterior portion being shortened, the heel projecting, and the toes pointing downwards. The head of the astragalus is very evident, forming a rounded globular swelling under the tense skin.

In the **inward** displacements, the foot is somewhat inverted, so that the outer malleolus is unduly prominent, and the inner malleolus is lost in a deep depression caused by the lateral displacement of the os calcis; the foot is thus in a position somewhat simulating talipes equino-varus. In the **outward** dislocations, the foot is somewhat everted, the inner malleolus prominent, and the outer buried, a position of talipes equino-valgus being thus assumed. In both forms the tendo Achillis is curved, with its concavity towards the displacement. The *Treatment* consists in reduction by manipulation, which is sometimes readily accomplished, but may at others be a matter of the greatest difficulty, probably from the tibial tendons becoming hitched around the neck of the astragalus. Section of the tendo Achillis may be sometimes needed.

The other tarsal and metatarsal bones are occasionally displaced, as also the phalanges, but these lesions require no special notice.

CHAPTER XVI.

HEAD INJURIES.

Injuries of the Scalp.

WOUNDS of the scalp are produced either by sharp or blunt instruments, by falls on the head, or by gunshot injuries. From the tenseness of the scalp over the cranium, it often happens that a blunt weapon, such as a policeman's truncheon, will cause a wound as cleanly cut as if it had been made with a sharp instrument. The depth to which the injury extends is a most important element in these cases, and, so long as it is limited to those parts superficial to the occipito-frontalis aponeurosis, but little harm is done; if, however, the layer of loose cellular tissue between the aponeurosis and the pericranium is opened up and infected, septic cellulitis (p. 96) of a most virulent type is likely to ensue, and even fatal consequences result. The superficial extent of the wounds is a matter of little moment, since the vascular supply is so good that sloughing is uncommon; a large portion of the scalp may be torn up and bruised, and yet, if it is carefully washed and rendered aseptic, there is every probability of its retaining its vitality.

The **Treatment** of scalp wounds is conducted on exactly the same lines as that of wounds elsewhere; that is to say, after efficient purification they may be stitched up, provision being made for drainage, if necessary. The hair should be previously cut away from the neighbourhood of the wound, and an antiseptic dressing applied. Hæmorrhage from the scalp may be severe, owing to the division of some of the large arterial branches; it is dealt with according to the general rules of surgery.

Contusions of the scalp may occur without solution of continuity of the surface, and result in the formation of bruises or hæmatomata. A similar condition is found in new-born infants; they are due either to pressure or injury to the head during its passage through the mother's pelvis, or to the compression of obstetric instruments. Three varieties of the so-called *cephal-hæmatoma* have been described, viz.: (*a*) the *Superficial*, which, confined to the dense subcutaneous tissue, is necessarily small and limited;

(*b*) the *Subaponeurotic*, occupying the loose tissue under the aponeurosis, and only limited by the attachments of this structure. It forms a large, soft, fluctuating swelling, upon which the scalp appears to float, and bags down over the eyes or occiput. Considerable bruising of the eyelids is often present. (*c*) The *Subpericranial* is limited by the pericranium dipping down into the sutures around the bone with which it is connected. Most commonly it forms over one of the parietal bones, presenting a soft, fluctuating swelling, which soon gains an indurated margin owing to a deposit of fibrin, and in this condition may simulate a depressed fracture of the skull, inasmuch as the cup-like fluid centre allows the finger to sink in and touch bone below. It is not difficult to recognise, however, since the indurated margin can be readily indented by the finger, whilst the edge is definitely raised above the surface of the cranium, and hence the sensation of depression of bone felt through the fluid is only apparent. *Treatment.*—All that is required is the application of evaporating and cooling lotions. There is hardly ever any need to lay open or drain these swellings.

Traumatic Cephal-hydrocele is the name given to a rare condition following head injuries, especially in children. It is characterized by the formation of a fluid swelling under the scalp, which pulsates synchronously with the heart-beat, and has a definite impulse on any expiratory effort; it varies in size from time to time, and is sometimes partially reducible. It contains cerebro-spinal fluid, and is due to a simple fracture of the vault, laying open either one of the lateral ventricles or the subarachnoid cavity. In one case it was proved on operation to be in connection with an arachnoid cyst, due to a localized subarachnoid hæmorrhage. Probably it is wise to leave this condition studiously alone, although, if one could be tolerably certain that the ventricle was not affected, it might be laid open and drained.

Injuries to the Cranial Bones.

Contusions of the Cranial Bones apart from fracture may lead to results which are most serious. 1. Many of the inflammatory conditions of bone described elsewhere may be lighted up; *e.g.*, if the patient is in a condition of low germicidal power, acute osteomyelitis may follow, associated with pyæmia from thrombosis of the large veins of the diploe, or chronic and sclerosing osteitis and periostitis may supervene with overgrowth of the bone, local or diffuse. Syphilitic or tubercular manifestations may be similarly lighted up if the patient is the subject of either of these diseases (see Chapter XXI.). In their treatment pus must be evacuated, necrosed fragments removed, and, if pyæmia arise from diploic infection, the outer table should be removed, and the sloughing diploe scraped away and purified. 2. In addition to such osseous conditions, pus may form within the cranium outside the dura mater (*subcranial abscess*, p. 484), and necessitate trephining. The dura mater may also be detached by a simple contusion, leading to meningeal hæmorrhage (p. 475). 3. Any of the cerebral lesions detailed hereafter may be produced, so that contusions of the cranium must never be treated lightly, even when they are associated with unbroken skin; much more so, then, are they serious when they are compound, sepsis being thereby readily admitted.

Fractures of the Skull.—These may be described for convenience under the following headings: *Fissured Fractures of the Vault; Fractures of the Base* (usually fissured); and *Depressed or Punctured Fractures.*

I. **Fissured Fractures of the Vault** are always due to external violence, direct or indirect. In the former case the skull first yields at the injured spot, but a fissure may extend from it for some distance; in the latter the fracture results from the yielding of the skull when compressed beyond its natural limits of elasticity.

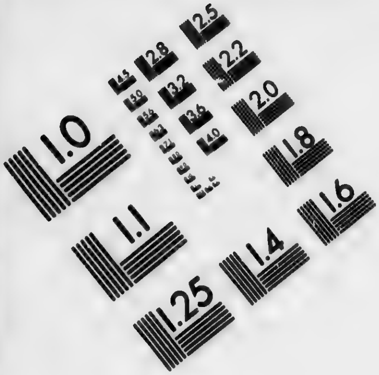
A simple fissure gives rise to no symptoms indicating its presence with certainty. There may be some amount of superficial ecchymosis together with concussion of the brain, but nothing more definite. When compound the line of fracture may be seen as a red streak, or even felt with the finger as an irregular ridge. It may consist of a mere longitudinal fissure, or may be starred; if uncomplicated with other injuries it is of but little importance, and needs nothing beyond general treatment—of course, the greatest care being taken to ensure asepsis. Occasionally, however, an osseous growth may form from protuberant callus on the internal aspect of the cranium at the site of fracture, and give rise to traumatic epilepsy (p. 497).

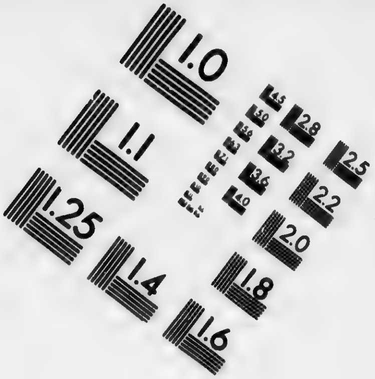
II. **Fractures of the Base of the Skull** are almost always fissured, only occasionally punctured or depressed. They constitute a most serious and important form of head injuries.

Causes. — There are three main conditions on which they depend. (*a*) *Violence may be directed to the vertex or to some part of the cranial convexity*, as from a blow or fall upon a hard substance. There has been a good deal of discussion as to how a fall on the vertex causes fracture of the base. The old idea of contre-coup, *i.e.*, that the force was transmitted from one side of the skull to the other, producing a fracture, may be decently buried and forgotten, whilst two main theories still hold the field, each being probably responsible for a certain number of cases. (i.) Aran's theory of *irradiation* maintains that a fracture of the base is always due to direct extension of the fissure from the injured vertex, an explanation probably quite true in many cases, but insufficient to explain all. (ii.) A more recent idea, known as the *bursting or* *compression theory*, is based on the fact that the cranium is not a solid and totally unimpressionable body, but is highly elastic, as has been proved by the observation that hairs and pieces of skin have been found nipped in a simple fissured fracture of the vault, which had evidently gaped open and closed again. Severe compression, as by a fall on the vertex, will necessarily diminish the diameter of the skull along the axis of greatest pressure, making it bulge in other diameters; and at the spot of greatest distension the bone gives way. The direction of fractures of the base produced experimentally is given by Messerer as evidence in favour of this theory. Thus, it is claimed that the line of fracture is at right angles to the direction of the force; antero-posterior violence produces a transverse fracture, and lateral compression leads to a longitudinal fissure. Speaking generally, this is probably true, allowing for modifications due to the irregular thickness and density of the bony walls, and for the intervention of sutures. Some authors, however, maintain that the lines of fracture run in exactly the opposite direction—that is, parallel to the direction of the compressing force. (*b*) *Direct injury* to the base of the skull is undoubtedly the cause of a certain number of fractures, and some of these are depressed, and not fissured, in character. Thus, the point of an umbrella or stick may be thrust through the upper wall of the orbit, or up the nose through the cribriform plate of the ethmoid; the condyle of the jaw may be driven through the glenoid cavity into the middle fossa by a blow on the chin; direct injury from a fall or a stab may penetrate the occipital bone, whilst a gunshot wound in the mouth is another illustration of this kind of injury. (*c*) The *impact or resistance of the vertebral column against the occipital condyles* produces fractures in the posterior fossa which radiate from the foramen magnum, and may even occasion a ring-shaped fracture around it (Fig. 155). They result from falling on the vertex into a soft mass, *e.g.*, a bale of wool, or by alighting from a height on the heels or nates.

The fracture may run in any *direction*, longitudinal, oblique, transverse, etc., according to the direction of the compressing or fracturing force, and it may involve any part of the base, either being limited to one of the fossæ or involving all; most tend to follow the sutural lines in part, but it is no uncommon thing to see even the dense petrous bone traversed by a fissure (Fig. 156). Naturally, transverse fractures tend to be limited to one of the fossæ, whilst a longitudinal fissure may involve them all.

Some fractures of the base of the skull are simple in nature, but the majority are *compound*. In the anterior fossa the fissure extends through the cribriform plate and nasal mucosa, and then lays open the nose; or a communication may be established with the external air through a penetrating wound in the orbit, or through the ethmoidal or sphenoidal sinuses. In the middle fossa a fracture through the base of the sphenoid opens the roof of the





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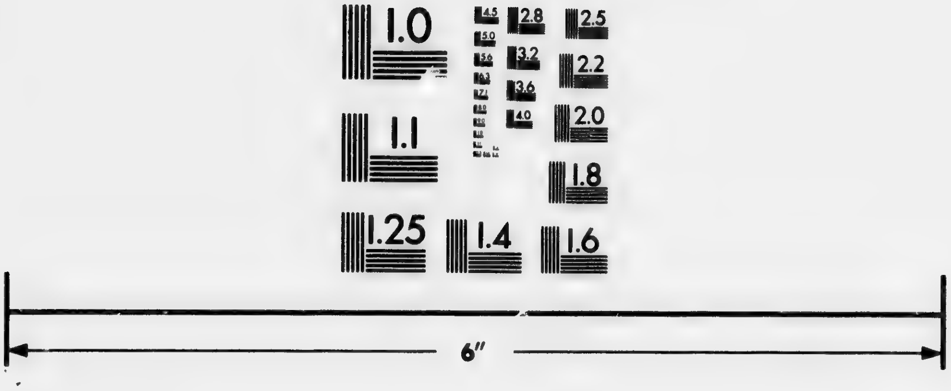

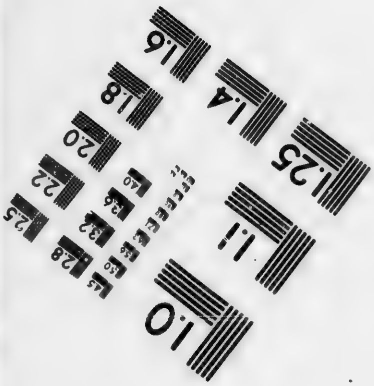

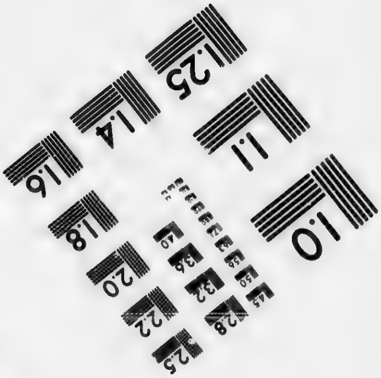

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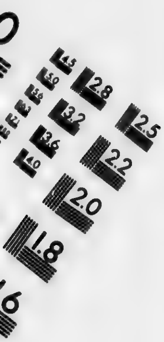
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naso-pharynx, or the fracture may involve the tympanic cavity. In the posterior fossa the basi-occipital may be broken, and the naso-pharynx again opened, although the fracture here is more commonly simple.

Fractures of the base of the skull, though exceedingly serious, are by no means necessarily fatal, and, indeed, during the last twenty years or more the statistics have immensely improved, owing to the use of antiseptic precautions. The main *dangers* to be apprehended are: (i.) Damage to the base of the brain, including the pons and medulla, especially in cases where the foramen magnum is splintered from the impact of the spine against the condyles; (ii.) hæmorrhage arising either from the venous sinuses or from the meningeal or cerebral arteries; and (iii.) septic meningitis, due to the fact that the injury not only fractures the bones, but also lays open the dura mater, a serious addition to a compound fracture.

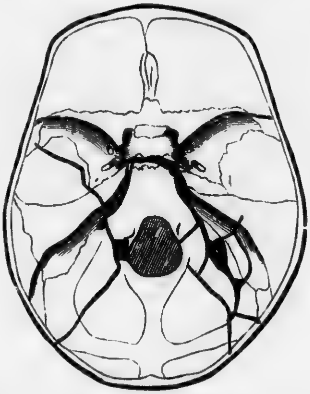

FIG. 155.—FRACTURE OF THE BASE OF THE SKULL FROM FORCE ACTING AGAINST THE OCCIPITAL CONDYLES, AND PRODUCING ALMOST AN ANNULAR FRACTURE AROUND THE FORAMEN MAGNUM. (TILLMANNS.)

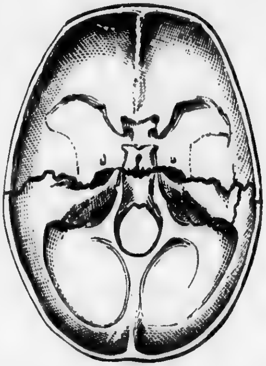

FIG. 156.—TRANSVERSE FRACTURE ACROSS THE BASE OF THE SKULL.

The **Signs** of a fractured base are exceedingly equivocal, and it is often only by a consideration of the whole picture that a certain diagnosis can be attained. For convenience they may be arranged under four heads:

1. *Signs of severe cerebral mischief*, such as is indicated by concussion of the brain and prolonged unconsciousness. This is, however, by no means always present; thus, in a case we had in hospital a few years back, the patient was capable of going about his work for ten days after the accident.

2. *Hæmorrhage* manifests itself in various directions, according to the situation of the fracture.

In the *anterior fossa* there may be free bleeding from the nose, owing to the fracture extending through the cribriform plate of the ethmoid; but a portion of the blood may pass backwards into the pharynx, and, being swallowed, is perhaps subsequently vomited. More often, however, the line of fracture runs across the roof of the orbit, causing escape of blood into the areolar tissue of this cavity. The ecchymosis shows itself as a gradually-developing subcutaneous distension, involving the lower lid, bluish-purple in colour at first, but passing later through the other stages of a bruise; there is probably no contusion of the skin, as in the ordinary black eye, which is at first reddish-purple; the ocular conjunctiva is considerably involved, but the effusion rarely extends above the cornea. The bleeding usually arises from laceration of the dura mater and bone, but, when abundant, may come from the cavernous sinus, and the eye may then be pushed forwards (proptosis); in some cases pulsation is to be felt within the orbit, and then a traumatic orbital aneurism or aneurismal varix is probably present.

In the *middle fossa* the blood may enter the nose or mouth, a part being swallowed, but more commonly it escapes from the ears. It may be abundant, and then probably comes from one of the vascular channels at the base of the brain; or it may be only slight in amount and of short duration, a condition which may be induced by any of the following lesions, as well as by a fractured base, viz.: (*a*) A simple rupture of the membrana tympani; (*b*) separation of the cartilage of the pinna, with tearing of the lining of the external meatus; (*c*) fracture of the anterior and lower part of the tympanic plate, as by a blow on the jaw, which drives the condyle forcibly against it.

In the *posterior fossa* the bleeding is usually subcutaneous, showing itself around the mastoid process, and extending downwards amongst the muscles at the back of the neck.

3. *Discharge of cerebro-spinal fluid* is an indication that a communication exists with the subdural space. The fluid may be discharged from one or both ears, but has been met with coming from the nose or cranial vault; when from the ear, the dura mater has probably been laid open through the prolongation which accompanies the auditory nerve in the internal meatus by a fracture traversing the petrous bone. It is watery and limpid in character, with a specific gravity of about 1005, slightly alkaline, and containing a fair quantity of chloride of sodium, with traces of albumin, and of a substance known as pyrocatechin, which reacts in the same way as grape sugar with Fehling's solution. At first it may be slightly blood-stained, but this soon ceases, the fluid becoming quite clear. The amount discharged may be small, but not unfrequently it comes away in large quantities,

soaking the pillow and dressings, and, indeed, can sometimes be caught in a test-tube as it trickles from the meatus. As a rule, the flow commences soon after the injury, and quickly ceases; but a few years back a curious case occurred, under the care of Lord Lister at King's College Hospital, of a man who had fallen backwards off a high bed on to his occiput; he was temporarily stunned, but returned to bed, and, on awaking the next morning, found that both eyes were black. He continued work for some days, complaining, however, of headache, and at the end of that time of earache, which grew worse and worse, until relieved by something giving way in his left ear. This was followed by a copious discharge of cerebro-spinal fluid, which was maintained for some time, and from the after-history there can be no doubt that it was due to a fractured base.

4. *Lesions of the nerves* issuing from the base of the skull are occasionally seen. For symptoms, etc., see Chapter XII. The nerve most commonly involved is the facial, as it passes through the aqueductus Fallopii, and paralysis of this nerve may result either immediately, or more often about the second or third week after the injury, disappearing in about a month, and then evidently due to its implication in the callus. A certain amount of deafness is often associated with it from injury to the portio mollis.

The **Prognosis** of fractured base has much improved during recent years, as a result of the application of antiseptics to the auditory meatus, thereby preventing the occurrence of sepsis within the meninges. If the patient escapes death from cerebral complications, the bones of the skull unite rapidly, and a good result may be expected, although troublesome sequelæ may follow, from the injury sustained by nerves or vessels, or their compression in callus or new bone.

Treatment.—Seeing that the chief danger to the patient arises from septic contamination of the meninges, the greatest care must be directed towards preventing decomposition of the discharges. Unfortunately, it is impossible to apply dressings to the naso-pharynx, or even to thoroughly wash it out with antiseptics, and the only satisfaction about such cases is that the rarity of the loss of cerebro-spinal fluid suggests that the membranes of the brain are not very often damaged in that situation, whilst it has also been shown that in the majority of cases the upper part of the nasal cavity is aseptic. With the ear, however, things are very different; the meatus should be well syringed with carbolic lotion (1 in 20), and plugged with some efficient dressing, a large pad of the same being bandaged over the affected side of the head. This must be replaced as often as necessary. Beyond this, the treatment of fractured base is directed to the cerebral condition, and does not differ from that usually applied to head injuries, viz., cold to the shaved head (preferably by means of Leiter's tubes), a smart calomel purge, low diet, and absolute quiet in a dark room.

The patient should be kept from going about his work for at least six weeks.

III. **Depressed and Punctured Fractures** usually involve the vault of the cranium, and are due to direct violence, either from a fall or blow, causing a simple or compound fracture, or from a penetrating injury occasioning a punctured fracture. Usually there is in both cases a considerable amount of comminution.

It is quite possible for the outer table to be broken and depressed, without any injury to the inner, where an air cavity exists in the bone, or where the diploe is very thick; thus, the bone may be driven in over the frontal sinus without injury to its inner wall, or the mastoid may be similarly affected. The inner table has been known to be fractured, and fragments even separated, as a result of depression with simple bending of the outer table; this rarely occurs in adults, but is not uncommon in children. Amongst the latter, it is also possible for a considerable depression to be met with without any fracture even of the inner table.

More usually both inner and outer tables are involved, and where such is due to force reaching it from without, the inner table is always more damaged than the outer, especially in the punctured variety (Fig. 157, A and B). Where, however, the force is applied from within, as when a bullet has traversed the brain, the outer table suffers more than the inner. The causes of this condition are the same, from whichever side the force comes; we shall, however, only discuss the case of a wound coming from without. (*a*) The inner table is less supported than the outer, having merely the soft brain and dura mater within; and hence, just as a nail driven through an unsupported piece of wood causes ripping up of its under surface, so the inner table becomes extensively splintered. (*b*) The loss of momentum of the fracturing body will assist this; the greater the momentum of a bullet, the more cleanly it cuts, a smaller momentum breaking or splintering rather than cutting; of course, a considerable amount of force is expended in penetrating the outer table. (*c*) The débris caused by the injury to the outer table will add to the bulk of the penetrating body, and its wedge-like action still further increases the injury to the inner table. (*d*) All force tends to radiate and diffuse itself from the spot struck, and hence, if the outer table is first injured, the force will be felt over a wider area of the inner table.

The **Symptoms** and **Signs** arising from a depressed fracture vary widely in their nature, and are partly due to the injury inflicted on the bone, partly to that sustained by the brain, whilst the septicity or not of the wound is of the gravest significance.

Locally, when an external wound is present, one sees blood or cerebro-spinal fluid escaping, or even brain-substance protruding. The damage to the bone may be seen or felt, and the extent of

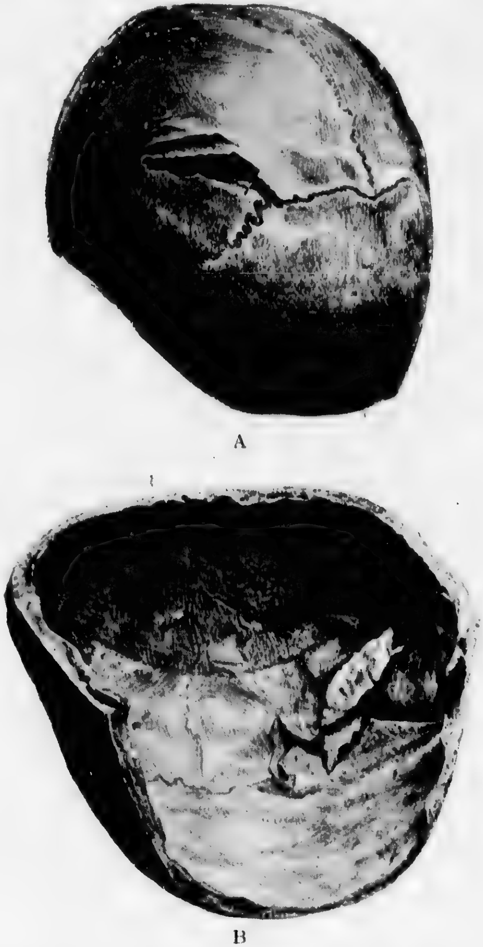

FIG 157.—DEPRESSED FRACTURE OF SKULL SEEN FROM WITHOUT AND FROM WITHIN. (FROM SPECIMEN IN KING'S COLLEGE MUSEUM.)

the depression or comminution ascertained. When there is no external wound, a hæmatoma of variable size forms under the scalp, more or less obscuring the fracture. The character of

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the lesion is a matter of considerable importance from a prognostic point of view. When the bone shelves evenly in all directions, a *pond-* or *saucer-shaped* fracture is said to be present, and such is tolerably amenable to treatment; when, however, the depression is sudden and complete, the detached portion lying below the level of the rest of the bone, it is termed a *gutter-shaped* fracture, and the prognosis is increasingly grave. The two varieties may, however, be associated. Necessarily, considerable variations are met with in this type of fracture, according to the nature of the injury by means of which it was inflicted. Thus, if it is due to a fall on the vertex, there is often a ragged, irregular scalp-wound, through which the depression can be seen or felt; if it is due to the puncture of a sharp tool, such as a pick-axe, there is only a small external opening corresponding to the hole in the skull, in which the point of the instrument may be found embedded. A sabre-wound or cut produces a clean incision through the scalp, together with a linear groove in the skull, perhaps somewhat bevelled, which may or may not penetrate its whole thickness.

Gunshot injuries of the skull manifest any degree of severity, according to the velocity and angle of incidence of the projectile. A non-penetrating wound produces either a severe localized contusion or a depression with or without comminution. If, however, a modern conical bullet, travelling at a high rate of speed, strikes the skull, it will probably penetrate, and possibly may traverse both sides, and thus escape. The apertures of entry and exit are not necessarily large, although the latter is very likely to be more obvious; but considerable additional mischief in the shape of fissures extending widely through the skull is induced by the explosive effect of the bullet passing through the brain. It has been known for some time, and the point has been recently emphasized by Professor Horsley, that if a bullet traverses a dry and empty skull but little harm results, except the infliction of the two openings where the bullet entered and left the cavity, and these with the modern weapon are small. If, however, the skull is first filled with damp sand or with water, or if the brain is left *in situ*, and a bullet fired through it, the effects are much more serious, varying directly with the viscosity of the contents; such a result is evidently due to the momentum of the penetrating substance being transmitted to the molecules of water or brain substance, and thence spreading explosive-like in all directions. Not only does this radiation of the force affect the skull, but the most grave consequences to the brain itself ensue from the displacement of cerebro-spinal fluid, inducing increased pressure upon the centres grouped around the fourth ventricle, and leading primarily to a cessation of the respirations. Thus, Horsley fired a bullet through the skull and brain of a living dog, and found that the breathing stopped, although the heart still continued to beat; by performing artificial respiration for a time, natural breathing was re-established.

In a *simple depressed fracture* the patient is very likely to suffer from concussion, followed almost immediately by compression, the latter due in part to the depressed bone, but also to exudation of blood and bruising of the brain, and if this remains unrelieved a fatal result almost inevitably follows. Where, however, the depression is but slight, the symptoms of compression may be absent or not marked, and the patient recovers, to become perhaps the subject of traumatic epilepsy later on, induced by the irritation of the dura mater and of the subjacent cortex. If the depressed fragments irritate the motor area, convulsions, spasms, or paralysis may thereby be early induced. It is unlikely that a simple depressed fracture will give rise to suppuration.

In a *compound depressed or punctured fracture* the immediate effects are not necessarily severe, the patient perhaps not even suffering from concussion, though brain substance presents in the wound; the more limited the spot injured, the less the concussion. The explanation of this fact is that the blow has expended its force in fracturing the cranium, and hence does little harm to the brain, in the same way as a watch may receive but little damage from a fall if the glass is broken, whilst if the latter remains intact the works are liable to suffer.

Left to itself, such a fracture is sure to become *septic*, and inflammation of the bone, brain, or membranes, is very likely to follow.

Septic osteitis leads to necrosis of the fragments, which may be seen lying dead and yellow at the bottom of the wound, whilst the inflammation may either spread along the diploe to the surrounding bone, causing extensive necrosis with pyæmia, or between the bone and the dura mater, leading to a subcranial abscess.

When once the dura mater has been penetrated, inflammation is liable to spread to the meninges, and then a diffuse or localized suppurative meningitis, accompanied or not with a localized suppuration of the brain, will ensue. Even if the dura mater has not been opened by the injury, the irritation of depressed spicules of bone and septic exudation will lead to its ulceration at a later date. If there is a free external opening, allowing a ready exit to the discharge, and thus preventing tension, the process may be quite limited, and compression of the brain or diffuse septic meningitis is avoided; but if the bones are locked together as well as depressed, and the external wound small, tension of inflammatory products may lead to their diffusion, and the symptoms of compression will soon become evident. A hernia cerebri may also form subsequently.

When the fragments of depressed bone are early removed, even if perfect asepsis is not attained, the patient has a good chance of recovery; whilst, even if the dura has been lacerated, meningitis need not follow, since the opening in the subdural space can be shut off by adhesions of the arachnoid in a very short time.

When an *aseptic* condition of the wound is obtained by early interference, and depressed fragments of bone are successfully removed, the prognosis becomes much better, and the case may run an uncomplicated course towards recovery, unless some deeper cerebral lesion co-exists.

In the **Treatment** of these cases surgeons have become more confident and energetic since the introduction of antiseptics. We have now no fear of using the trephine, or of even opening the membranes and exploring the brain, and hence we may justly conclude that a patient runs greater risk from leaving a slight depression unrelieved than by making even what may prove to be an unnecessary exploration with the trephine. We may, therefore, epitomize the treatment thus:

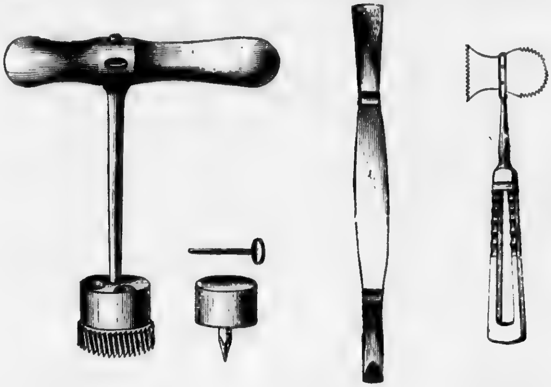


FIG. 158.—INSTRUMENTS USED IN TREPHINING FOR OR ELEVATING A DEPRESSED FRACTURE, INCLUDING TREPHINE, ELEVATOR, AND HEY'S SAW. (DOWN BROTHERS.)

(i.) In all punctured fractures, operate.
(ii.) In all compound depressed fractures, operate.
(iii.) In simple depressed fractures: In adults, always operate; in children, if gutter-shaped, operate; if pond-shaped, wait for symptoms, unless the fracture is a bad one.

The most debatable of these propositions is that relating to the simple depressed fracture in an adult. It may be objected that many such cases have recovered without operation, and that therefore in shallow depressions one should wait for symptoms; but whilst admitting these facts, we recall cases where the neglect of such treatment has later on led to the most serious trouble, and we have been called on not unfrequently to trephine for traumatic epilepsy due to this very type of injury. The operation is so slight, and the risk so insignificant when asepsis is maintained, that the patient should be given the benefit of an exploration, especially since one can never be certain of the amount of injury sustained by the inner table.

When an operation has once been decided on, the sooner it is undertaken the better. The scalp should be shaved and thoroughly purified. An anæsthetic may or may not be given, according to the condition of the patient. In a simple depressed fracture the surgeon should never incise the skin directly over the wound, but should turn down a flap to avoid the presence of a cicatrix over the lesion in the bone. Having cleared away any blood-clot and exposed the fracture, if there is no projecting margin of bone he will have to trephine, placing the centre-pin upon some firm undepressed bone as near the edge of the wound as possible (Fig. 159). An elevator can now be introduced, the fragments prised up into position, and the condition of the inner table investigated. The opening in the skull may be enlarged by cutting pliers or a Hey's saw, but all the bony tissue taken away during the operation should be kept in warm boracic lotion, or, better still, in warm saline solution or blood serum, if obtainable. When the loss of substance is small, there is no need to replace the fragments, but where it is of considerable size it is wise to attempt this, wedging them accurately together, so that none of them lie loose in the wound. An opening for drainage may be left between them, if need be. In other cases they may be chipped up into small pieces and powdered over the wound.

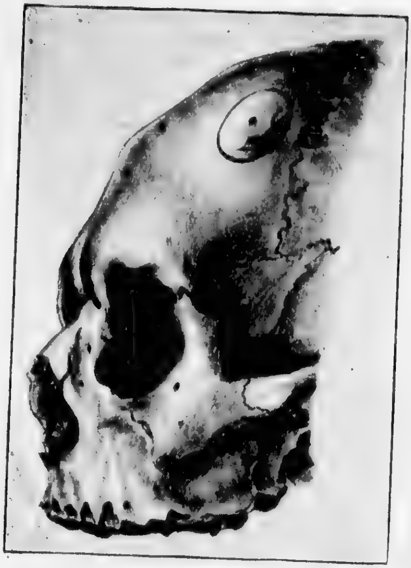


FIG. 159.—PUNCTURED FRACTURE OF SKULL, SHOWING SPOT FOR APPLICATION OF TREPHINE.

In a compound depressed fracture, the skin-wound may be enlarged, or a flap turned down, and the bone dealt with according to circumstances. It may suffice to saw off a portion of a projecting fragment, so as to allow entrance to the elevator, or it may be necessary to apply a trephine. In these cases, the fragments of bone removed must be well purified in warm carbolic lotion (1 in 40) before being placed in the saline solution. The brain and membranes will need careful purification if wounded, and this may be accomplished without fear by washing with a 5 per cent. carbolic solution. Protruding brain substance may be removed, and the dura mater lightly stitched across the gap; the bones may then be replaced, but room must be left for a drainage-tube to pass within the dura to carry away any fresh effusion; it may be removed, if the case progresses satisfactorily, in forty-eight hours.

In a punctured fracture, although the opening in the bone may be small, a large circle should be removed, since the inner table is generally extensively damaged. The centre-pin should rest on sound bone, as near the opening as possible, and care must be taken to include all depressed fissures in the field of operation.

In all cases the patients should be confined to bed with the head low, and the general rules suitable to all head injuries followed. It is by no means certain that elevation of the depressed bone will relieve the symptoms, as they may be due to hæmorrhagic effusion into the brain which cannot be reached.

Gunshot injuries of the skull are treated along exactly the same lines—by careful attention to antisepsis, and the relief of pressure from depressed fragments. If the position of the bullet can be located, an attempt should be made to extract it, if such can be done without serious risk; otherwise it is better left alone, and may then become encapsuled, since (as has been pointed out before) it is usually aseptic.

Injuries to the Intracranial Bloodvessels.

The extreme vascularity of the cranium and its contents readily explains the frequency with which intracranial hæmorrhage complicates most of these head injuries, and often determines a fatal issue.

1. **Wounds of the Venous Sinuses** are by no means uncommon accidents, being torn across in fractures, or punctured either by some sharp instrument, or by spicules of bone. The superior longitudinal, petrosal, lateral, and cavernous sinuses are those most frequently involved, especially the last, because it is more intimately connected with the bones than any of the others. When there is no external wound, and only the outer wall of the sinus has been opened, the hæmorrhage, if at all severe, will strip up the dura mater and compress the brain, producing effects resembling those due to meningeal hæmorrhage, but slower in their onset, and less severe in their course; if the wound is small,

the bleeding is not so great, since comparatively little pressure suffices to arrest it by flattening the sinus against the bone. If, however, the inner wall of the sinus is torn across, the blood finds its way between the meninges, and gives rise to the symptoms of diffuse intra-meningeal hæmorrhage. When an external wound exists, there is the usual evidence of venous hæmorrhage, but it is rarely fatal, since it is readily checked, either by Nature or the surgeon. Septic thrombosis and pyæmia are the chief dangers, but entrance of air has also led to a fatal issue in a few cases. **Treatment**, when practicable, consists in plugging the sinus with aseptic gauze, and applying an antiseptic compress, possibly removing fragments of bone in order to expose it. Where the outer wall alone has been torn, it may be possible to suture it without interfering with its continuity. For symptoms and treatment of septic thrombosis, see p. 488.

2. **Wounds of the Middle Meningeal Artery.**—This vessel, which enters the skull at the foramen spinosum, and subsequently divides into two branches which ramify between the skull and the dura mater, is occasionally ruptured, with or without a fracture of the skull. The anterior branch is most frequently divided as it crosses the anterior inferior angle of the parietal bone, as the result of a fissured fracture; but it is very liable to be torn by a punctured wound, since the bone is very thin in that locality, or by a depressed fracture. The artery is, however, sometimes ruptured by a blow on the side of the head, sufficiently severe to detach the dura mater, but without causing any injury to the bone; this membrane always carries the vessel with it, and if it emerges from a bony canal just at that spot, as so often happens, the artery is torn across by the projecting inner lip of that canal. Whether or not the dura is primarily detached, the blood soon collects between it and the bone, pressing the brain inwards, and tending to travel down towards the base of the skull (Fig. 160). Such is due mainly to the force-pump-like action of the arterial pressure, for when fluid is driven into a closed cavity, the power of the jet is multiplied by the area occupied. The clot rarely measures more than 4 inches in diameter. The posterior division is only wounded in about 5 to 10 per cent. of the cases.

The **Symptoms** are, unfortunately, often obscured by some co-existent cerebral lesion or complication; but in a typical case three stages should be present, viz.: (*a*) A primary concussion, as the result of the blow; (*b*) a temporary return to consciousness; and (*c*) the gradual supervention of coma within twenty-four hours, and that usually without any considerable rise of temperature. The interval of consciousness varies widely, but is not often longer than an hour or two, whilst in many cases it is scarcely recognisable. As accessory signs, the following may be mentioned: (*a*) Since the blood-clot is situated close to the motor area of the cortex, and especially over the centres for the head and arm, twitching of these parts, followed perhaps by paralysis, may be a well-marked feature; (*b*) when the clot extends to the base of the skull, it presses on the cavernous sinus, and may induce passive congestion of the eyeball, paresis of some of the ocular muscles, and proptosis, with possibly a dilated pupil and high temperature; and (*c*) when a fissure exists in the bone, blood may filter through into the temporal fossa, and cause a marked fulness in that region.

The **Prognosis** is extremely unfavourable, von Bergmann stating that, out of ninety-nine cases, only sixteen recovered.

The **Diagnosis** of subcranial hæmorrhage is easy if there is an open wound, or if the symptoms are at all typical; but even then it would be difficult in all cases to be certain that the middle meningeal artery had given way, and that the symptoms were not due to venous bleeding. An examination of the injury and of the part struck, and the rapidity of onset of the symptoms, may help in this matter, but it is often impossible to make a diagnosis with certainty.

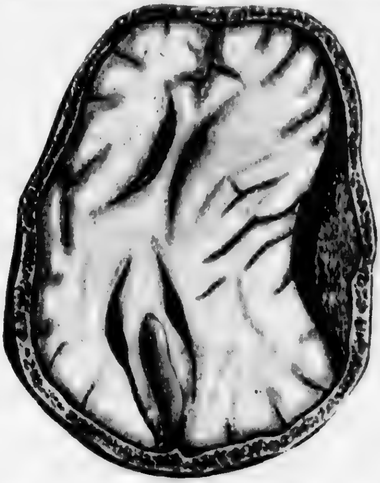


FIG. 160.—MENINGEAL HÆMORRHAGE. (FROM SPECIMEN IN COLLEGE OF SURGEONS' MUSEUM.)

The **Treatment** consists in trephining in order to remove the blood-clot, and secure the artery, if still bleeding. The spot selected for dealing with the anterior division of the artery is 1½ inches behind the external angular process of the frontal bone, and 1½ inches above the zygoma (Fig. 259, F), and this point should be marked on the bone with a bradawl through the scalp before commencing the operation. The scalp is shaved and thoroughly purified, and a flap turned down, including everything as far as the pericranium (Fig. 80, E). A crucial incision is then made over the selected spot, and the pericranium reflected sufficiently to allow a 1 inch trephine to be applied. On removing the disc of bone, a mass of blood-clot presents, which should be broken up with the finger and washed away. If the artery is seen bleeding on the dura mater, it may be possible to pick it up, and tie or twist it, or a fine curved needle threaded with catgut may be passed under it, and thus a ligature applied. If, however, the blood comes from a canal in the bone, the outer table must be clipped away from below, sufficiently to enable the canal to be seen and plugged by a small piece of aseptic wax, sponge, or gauze, which may be left without danger. The flap is then replaced, and stitched down, a drain-tube being inserted for a time.

The posterior branch of the artery can be reached by trephining immediately below the parietal eminence at the same level as for the anterior branch—*i.e.*, 1½ inches above Reid's base line; or, again, it can be exposed nearer its origin at a spot 1¾ inches behind the external angular process of the frontal bone, and ¼ inch above the upper margin of the zygoma (Fig. 259, G).

3. **Wounds of the Internal Carotid Artery**, in its intracranial portion, are rare, but if complete are exceedingly fatal. It usually results from a penetrating wound of the orbit, or from a gunshot wound; or it may be torn by a splinter of bone in a fracture of the base of the skull. Mere fissures through the carotid canal may do little harm, since there is plenty of room within it around the artery. Occasionally, however, the artery is slightly torn, and an aneurismal varix results between it and the cavernous sinus. Of seventy-five cases of pulsating exophthalmos, Rivington found that forty-one were caused by trauma, and were probably of this nature.

Treatment.—The injury is fatal in the majority of cases before help can be obtained; if not, compression or ligature of the carotid trunk in the neck is the only hope. See also on intra-orbital aneurism (p. 265).

4. **Intrameningeal Hæmorrhage** may arise from wounds of the cerebral cortex or membranes in cases of fractured skull, or from concussion without fracture. The bleeding arises from the veins and capillaries so abundantly present in the pia mater, or from lesions of the inner wall of venous sinuses, or even from the middle meningeal artery, if the dura mater is also opened. It may be widely diffused over the surface of the hemispheres, or be more localized. It is, as a rule, only slowly absorbed, and may become encapsuled, constituting what is known as an arachnoid cyst, *i.e.*, a closed cavity containing serum, the walls of which are formed of fibrous tissue stained brown with hæmatin.

The **Symptoms** are those of cerebral compression, and usually supervene directly on concussion without any lucid interval. The coma is often of long duration, though, as a rule, not of great intensity. Perfect recovery may ensue, even though unconsciousness is prolonged for weeks; but often adhesions form as the result of a chronic meningitis lighted up by the accident, and this may lead to subsequent troubles. No focal symptoms are produced unless the hæmorrhage arises from or presses upon the motor area, when convulsions, or later on paralysis, may ensue.

The **Treatment** is merely symptomatic, the patient being kept absolutely quiet, and all excitement and noise which might induce cerebral congestion excluded. Should there be any focal symptoms indicating the position of greatest pressure, or should there be some concurrent lesion in the skull, the trephine may be applied at this spot. It must not be forgotten, however, that the chief hæmorrhage often occurs (as will be presently pointed out), not at the point to which the injury was directed, but at an exactly opposite spot on the other side of the cranium, and hence considerable uncertainty may arise both as to the advisability of an operation, and the site. Should the right locality have been exposed, the dura mater will probably bulge into the wound, after the circle of bone has been removed; it is blackish blue in colour, owing to the clot lying beneath it, and the cerebral pulsations will not be detected. It is carefully incised, and the blood-clot removed; any bleeding-points should be tied or compressed, or it may be necessary to insert a small wick of aseptic gauze for a day or two, in order to drain off serum and blood.

5. **Cerebral Hæmorrhage** occurs more frequently from idiopathic causes than from trauma, except in the case of severe lacerations. In the more aggravated forms, death is almost certain to follow in a short time from coma, whilst the symptoms of the less serious cases are discussed later on under the heading ‘ Lacerations of the Brain ’ (p. 489).

Injuries to the Brain and its Membranes.

These may be divided into two great classes—the general and the local.

General Conditions of the Brain after Injuries.

Concussion of the Brain, or stunning, is a clinical condition evidenced by a more or less complete suspension of its functions as a result of some injury to the head, which may or may not have produced an anatomical lesion. It varies with the severity of the cause from a slight momentary giddiness and confusion of thought to the most complete insensibility, and is closely allied to shock, from which, indeed, it is often distinguished with difficulty.

In fatal cases, one finds on post-mortem examination merely the same conditions as obtain in shock, viz., engorgement of the lungs, viscera, and the right side of the heart, whilst the brain presents some lesion of varying severity, from mere punctiform ecchymoses to actual disintegration and disorganization. The symptoms are supposed to be due to a paralysis of the vasomotor centres in the medulla, and subsequent loss of vascular tone, allowing the blood to gravitate to the most distensile parts, viz., the portal system. Reflex inhibition of the heart through the vagus may also assist in their production. More recently Duret has suggested that the blow on the skull causes a temporary depression, and this leads to compression of a cone-shaped area of the brain substance. As a result, the cerebro-spinal fluid is displaced and forced downwards to the base of the skull, where it tends to collect, particularly in the fourth ventricle, and thus the vital centres grouped around this space are compressed, and anæmia of the brain (which all authorities admit to be present) is produced. The explanation thus afforded of concussion is a very feasible one.

The **Symptoms** are exceedingly variable in degree, but in a well-marked case the stage of concussion is evidenced by unconsciousness, more or less complete, although the patient may sometimes be roused by shouting at him; he lies on his back, with the muscles relaxed and flaccid; the eyelids are closed, and the conjunctivæ often insensitive; the pupils vary, but are equal and often contracted, usually reacting to light. The surface of the body is pale, cold, and clammy, and in bad cases insensitive even to strong electric shocks. The respirations are slow, shallow, and sighing, whilst the pulse is weak, fluttering, and scarcely sensible to the fingers; the temperature is subnormal; the sphincters are relaxed, with perhaps unconscious evacuations from both bladder and bowel. The reflexes are present in the milder cases, though sluggish; in the more severe they may be entirely absent.

This condition may last for a considerable time, and then pass slowly into more profound unconsciousness and death, or be followed by the phenomena of inflammation, compression, or cerebral irritation. If, however, the case is going on to recovery, *reaction* soon begins to manifest itself. The patient is presumably put to bed, and careful warmth applied to the extremities. The first sign of reaction will probably be a slightly increased rate of both breathing and pulse, whilst he may be able to tell his name and address; but often the earliest indication of recovery is that he turns on his side, and pulls the bedclothes up to his face, since he feels cold and chilly as a result of the cutaneous anæmia. Gradually he becomes more and more rational, and the functions of both mind and body are restored, reaction being fully established by the occurrence of vomiting, due to a condition of cerebral hyperæmia following the anæmia. Probably he will suffer from headache for some days, and a slight amount of fever will follow; but this passes off, and leaves the patient either quite well, or with a somewhat irritable brain requiring prolonged rest. Subsequent events may, however, prove that more mischief has been done than appears at once. One sequela of concussion may be that some special function of the brain is permanently lost or impaired, such as memory, hearing, or vision; thus, a patient may forget the names of places or persons, or may lose all memory of time; or speech may become defective or stammering, or a certain amount of asthenopia (weakness of vision) may supervene. Such individuals are very liable to recurrent attacks of inflammation, one of which may prove fatal. Others are left with an inordinately irritable brain, incapable of standing any excess of work or diet; and in such, a sudden fatal issue is not uncommon. Others, again, seem to suffer from a general loss of nerve tone (neurasthenia), rendering them incapable of fulfilling their ordinary duties in life.

The **Treatment** of concussion very closely resembles that of shock, viz., the patient is at once put to bed, with the head low, and is covered with warm blankets; hot-water bottles may be applied to the extremities, and friction to the surface. Any needless stimulation must be avoided, since it may suffice to light up bleeding; a little warm tea may be given him when he can swallow, or, if *in extremis*, brandy or ether by the rectum, or a hypodermic injection of strychnine. On the establishment of reaction, a good purge, such as 5 grains of calomel, should be administered, and the patient is then kept for some days in bed on a restricted diet, with the bowels freely open, and all causes of excitement excluded.

Where the unconsciousness is prolonged, and the cause of it cannot be readily ascertained, the head should be shaved, and an icebag or Leiter's tubes applied; the bowels should be kept well open, and the state of the bladder attended to; the room must be kept dark and quiet, the attendants making as little noise in walking and talking, etc., as possible; sufficient nourishment must be given, either by a spoon, if the patient can thus take it, or by nutrient enemata. In the former case iced milk and chicken broth or beef-tea must be depended upon.

Cerebral Irritation.—By cerebral irritation is meant a clinical condition characterized by great irritability of both mind and body, into which a patient sometimes passes after concussion. It usually follows blows or falls on the temple, forehead, or occiput, and is probably due to a superficial laceration of the brain, possibly in the frontal region, and the hyperæmia due to its subsequent repair.

The **Symptoms** are extremely characteristic, usually manifesting themselves two or three days after the injury. They may be divided into two groups. (*a*) *Bodily Symptoms:* The patient lies on his side in a condition of general flexion, the back arched, the legs drawn up to his abdomen with the knees bent, and the hands and arms drawn in. He is restless, and may toss himself about, but never fully extends himself, or lies supine. The eyes are closely shut, and he resists all attempts to open them; the pupils are contracted; the temperature is usually a little raised, but the surface of the body and head are both cool; the pulse is quiet, but weak; the sphincters are usually in a normal condition, and the excreta are often passed in the bed, but the bladder may occasionally need to be emptied by catheter. (*b*) *Mental Condition:* The patient is by no means unconscious, but he takes no heed of what is passing around, and is intensely and morbidly irritable. When disturbed, he will gnash his teeth, frown, curse or swear, and resent the intrusion in the most expressive manner At the end of a week or two a marked alteration in the condition of the patient usually shows itself. He is less irritable, begins to stretch himself out, and with this is conjoined an improvement in both pulse and temperature. The change in his mental state sometimes becomes very obvious, since he may be quite childish and weak. 'Irritability gives way to fatuity' (Erichsen). In this stage he may need to be treated as a child, and even taught the names of persons and things; later on he may glibly detail the history and cause of his accident, giving a fresh story every day, so that his statements cannot be relied upon in any claim for compensation. After a time his brain recovers, but more or less serious after-effects are likely to ensue. Sometimes the symptoms pass over, however, into those of subacute or chronic meningitis.

In the **Treatment** the surgeon must remember that there is a considerable tendency to asthenia, and hence, while the patient is kept quiet and free from all noise or excitement, he must be well supported by a light and nourishing diet. The head should be placed low and shaved, and Leiter's tubes fitted on, if the patient will permit it; but it is better to omit this entirely than to apply cold intermittently. The bowels must be kept well open, and possibly small doses of bromides, or even opium, may be useful. If any signs of meningeal inflammation follow, such as rise of temperature and pulse, heat of head, and great sleeplessness, blisters or leeches may be applied locally, and mercury administered internally.

Compression of the Brain.—Compression is the term given to a clinical condition, due to some abnormal and excessive intracranial pressure, which disturbs the functions of the brain. When of traumatic origin, it may arise from the following causes: (*a*) Depressed bone or the presence of a foreign body, in which case the symptoms of concussion merge directly into those of compression, and usually without any interval of consciousness; (*b*) extravasation of blood within the cranium, either outside the membranes, or on the surface of the brain, or within its substance. If the bleeding be extradural, there will probably be a short interval of consciousness between the concussion and the compression; if the bleeding is cerebral, the symptoms of compression may manifest themselves at once without any interval being noticed. (*c*) It may be due to an acute spreading œdema, the explanation of which is subsequently given (p. 489). (*d*) It may arise from a collection of inflammatory exudation or pus, in which case the symptoms are preceded by those of inflammation, and at the earliest will not manifest themselves before the third day, whilst they may be deferred for a week or two.

Compression may also arise idiopathically as a result of hæmorrhage, tumours, gummata, or abscesses, *e.g.*, as a complication of middle ear disease.

The **Symptoms** of compression are essentially those of *coma*. When the condition is well established, the patient lies on his back absolutely unconscious, and cannot be roused either by shouting or shaking. His *breathing* is slow, laboured, and stertorous, the lips and cheeks being puffed in and out. The stertor arises from paralysis of the soft palate, and the puffing of the cheeks from paralysis of the facial muscles. In the later stages the respirations may be more rapid and irregular, somewhat approaching the Cheyne-Stokes type. Death arises from cessation of the respiratory act. The *pulse* is full and slow at first, but later on becomes rapid and irregular, owing to increased pressure upon and exhaustion of the medullary centres. The *surface* of the body may either be cool, hot, or perspiring; the body *temperature* similarly varies, in some cases being hyperpyrexial, in others low, and where the compressing force is unilateral, there may be some difference on the two sides of the body. The *pupils* tend to become dilated without responding to light, but vary according to the degree of compression and the situation of the compressing agent. If the cerebral pressure is equally diffused, both pupils first contract, and then gradually dilate and become reactionless; but if one hemisphere is affected more than the other, the pupil on that side passes rapidly through these changes, whilst on the opposite side they are not developed until later. Thus, it is a common thing to find the pupils unequal in size, and reacting differently to light. The whole body in the later stages is in a condition of *motor paralysis*, but at an earlier period of the case there may be some difference on the two sides, if the lesion is unilateral; thus, if the left side of the brain is primarily affected, a right-sided hemiplegia is likely to be present at a time when the muscles on the left side can still respond to cerebral stimuli. A localized compression involving the motor area may lead to convulsions in the corresponding group of muscles. The bladder is paralyzed, and hence retention ensues, whilst the sphincter ani is relaxed, and fæces pass involuntarily, although marked constipation is usually present.

The symptoms in some cases are ushered in by severe pain or headache, which is partly due to pressure upon and tearing of the dura mater, and partly to the altered vascular conditions of the brain; the brain substance itself is not sensitive, and hence the pain is not directly referable to any lesion of or pressure upon it. Naturally the clinical picture is modified according to the cause of the compression, and it is impossible to discuss here more than the general features. The course of the case, too, varies widely according to whether or not the compressing agent can be removed by the surgeon, or absorbed by natural processes. Patients not uncommonly recover from small cerebral and intrameningeal hæmorrhages causing temporary compression, but rarely so if it is due to depressed bone, the presence of a foreign body, or large exudations of blood, serum, or pus, unless operative proceedings can give relief.

The **Diagnosis** of coma from compression, when a complete history of the case can be obtained, is often easy, and, indeed, the whole clinical aspect may be so typical that no question as to the cause of unconsciousness can be raised. But when a person is found in the streets unconscious, where no history either of the patient or of the accident is obtainable, and where no serious lesion of the skull is present, the diagnosis is often extremely obscure, since coma may result from many other causes, *e.g.*: (*a*) Cerebral lesions, such as apoplexy, whether the result of hæmorrhage, embolus, or thrombosis; or it may be the consequence of a preceding epileptic fit, or due to a rapidly spreading œdema in cases of cerebral tumour or abscess. (*b*) Various toxic agents may induce coma; they may be introduced into the system from without, as in the case of alcohol, opium, or other narcotics, or may be developed within the body, as in uræmia or diabetic coma. (*c*) Heatstroke or exposure to cold may also lead to unconsciousness. In the latter case there can be but little doubt as to the cause, since the patient is cold, pale, and in a state of severe prostration; in the former the diagnosis may for a time be doubtful. (*d*) Lastly, it must not be forgotten that two or more of these conditions may co-exist. Thus, a drunken man may fall and break his skull, and then the smell of liquor in his breath may lead to an erroneous diagnosis.

It is therefore evident that a very careful examination of the patient is required before any conclusion can be arrived at as to the cause of the coma, and even then it may be impossible to make a diagnosis. In such cases the patient should be carefully tended and watched, and not condemned to the risk of being shut up for the night in a police-cell without attendance.

The following points should always be observed in the examination: (1) A rapid note should be made as to the surroundings of the patient—whether there is blood or vomit near him, how the body is lying, and the nature of the ground. (2) The depth of the coma should be ascertained, and, if possible, he should be roused, and asked to give an account of himself. (3) A most thorough and complete investigation should be made as to his condition. His skull must be first examined, to settle if possible whether there is a fracture present; the surface temperature of the body is noted, as also the character of the pulse and respirations. The tongue should be looked at, as it is often bitten in an epileptic fit, and the smell of the breath should also be noted. The condition of the pupils may throw some light on the case; in opium-poisoning they are small and equal, a condition also seen in hæmorrhage into the pons; in alcoholism they are often dilated and fixed, but vary considerably with the depth of the coma. The amount of power and the state of the reflexes are then observed, any inequality probably indicating a unilateral lesion in the brain. The urine must be drawn off, and carefully examined for albumin and sugar. (4) In dubious cases, and especially where there is any suspicion of drunkenness or poison, recourse may be had to the stomach-pump to empty the viscus. (5) Finally, if the cause is still uncertain, the patient should be put to bed and carefully watched.

The **Treatment** of compression must be, where possible, directed to removing the cause. When it is due to depressed bone or a foreign body, such are dealt with if feasible by immediate operation; collections of pus should be opened and blood-clots removed. Failing such measures, the treatment of the condition resolves itself into keeping the patient quiet, with the head low and cool, the room dark and noiseless, the bowels open (using croton-oil on sugar, or enemata, for this purpose), and the bladder empty. The patient may have to be fed per rectum, and if the breathing or pulse is very laboured, and cyanosis begins to show itself, free venesection may be advisable. Considerable interference with the respiration may arise from falling back of the tongue, as often occurs in profound anæsthesia during surgical operations, and if due to this cause the head may be rolled over to one side, or the tongue pulled forwards. Occasionally patients remain in this condition for weeks or months.

Intracranial Inflammation.—Inflammation of the cranial contents is often met with as a result of injury, and although we shall describe several distinct varieties, it must be remembered that the various forms run into one another, and that in practice mixed types are the more common, giving rise to a corresponding complexity of symptoms. For descriptive purposes the following groups may be distinguished:

(i.) **Subcranial Inflammation.**—This may occur in the form either of an effusion of pus between the dura mater and the bone (*subcranial abscess*), or as a thickening of the dura mater (*pachymeningitis*).

The former results from either a compound depressed or a punctured fracture, in which the dura mater is only separated from the bone and not lacerated, especially when the external wound is small and efficient drainage is not obtained. It sometimes occurs, however, in consequence of a simple contusion or fracture of the skull, leading to a detachment of the membranes, and a collection primarily of blood and later of inflammatory fluids in the cavity thus produced. Microbic invasion is here due to auto-infection, or to the passage of organisms through the bone. Apart from injury, its most common cause is, without doubt, extension of inflammation either from the superjacent bone or from the middle ear. The **Symptoms** produced are those of suppuration, viz., a high temperature, with perhaps rigors, and signs of intracranial pressure in the form of fixed headache followed by coma. If there is no open wound, an œdematous swelling of the scalp, known as *Pott's puffy tumour*, may develop over the site of the abscess. When there is a wound, and a fissure or fracture of the skull, the margins look unhealthy, and at its base may be seen bare bone, yellow and dry, from which the pericranium has separated, with perhaps pus oozing out between the fragments. If the pus burrows towards the base of the skull optic neuritis may develop, whilst focal symptoms of spasm or paralysis may complicate the case if the dura over the motor area is involved. The **Treatment** of such a condition consists in evacuating the pus through a sufficient opening made by trephining, or by removing loose portions of bone and providing for drainage. Sometimes more than one opening is required for this purpose.

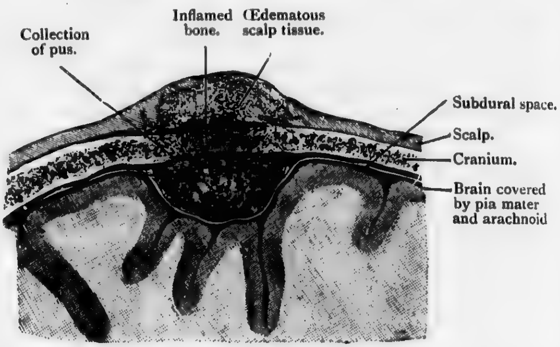


FIG. 161.—SUBCRANIAL SUPPURATION, INVOLVING OVERLYING BONE AND CAUSING AN ŒDEMATOUS CONDITION OF THE SCALP—POTT'S PUFFY SWELLING (SEMI-DIAGRAMMATIC). (FROM TREVES' 'SYSTEM OF SURGERY.')

Simple pachymeningitis, or thickening of the dura mater, may result from a slight simple depressed fracture, or even from contusion with or without a fissured fracture. No immediate symptoms need arise, but those characteristic of chronic meningitis described below may be met with at a later date; in fact, it is impossible to distinguish clinically between the two affections.

(ii.) **Acute Diffuse Meningitis** is practically always infective in nature, although a simple form used to be described, supposed to result from merely mechanical causes, but probably also due to bacteria of lesser virulence, such as the pneumococcus. The symptoms vary considerably in their intensity, according to the method of inoculation and the activity of the organisms. The superficial part of the brain is involved in the inflammation as well as the meninges, and the term meningo-encephalitis would perhaps be the better appellation.

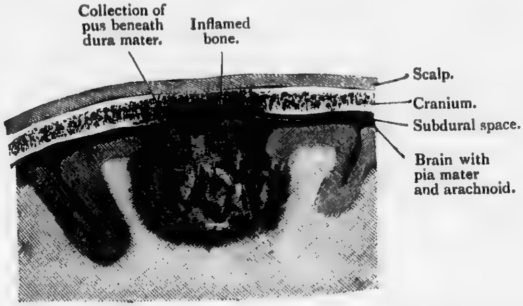

Collection of pus beneath dura mater.
Inflamed bone.
Scalp.
Cranium.
Subdural space.
Brain with pia mater and arachnoid.

FIG. 162.—SUPERFICIAL ABSCESS OF BRAIN, SPREADING FROM SUBDURAL SPACE (SEMI-DIAGRAMMATIC). (FROM TREVES' 'SYSTEM OF SURGERY.')

The **Symptoms** manifest themselves about forty-eight hours after the injury, although sometimes infection may be delayed beyond this period. In the early stages the patient complains of severe, constant, and increasing headache, associated with heat of head, a forcible pulsation of the carotids, a full pulse, and general irritability of the brain, as indicated by vomiting, intolerance of light and sound, delirium, and perhaps convulsive twitchings of the muscles, not only of the head and back, but also of the extremities. High fever is usually present, and possibly a rigor may occur at the onset. As the disease progresses, the patient gradually passes into a state of coma, due to cerebral compression, which usually persists until death ends the chapter.

According to the site of infection, the pathological phenomena may manifest themselves more acutely over one part than another, and for descriptive purposes two chief varieties have been distinguished, viz., meningitis of the convexity and of the base. The general symptoms are alike in both forms, but slight modifications occur in the details. Thus, when the convexity is involved, convulsions are a more prominent feature in the case, and may at first be limited to localized groups of muscles, whilst in basal meningitis the temperature tends to run higher, the head and neck are more retracted, optic neuritis is more frequent, and some form of squint is not uncommonly observed.

On *post-mortem* examination the skull-cap may be separated from the meninges with some difficulty; the dura mater is thick and congested, and the subjacent veins manifestly distended; the cerebro-spinal fluid is increased in amount, and turbid from admixture with lymph or pus; the arachnoid is thick and opaque; the surface of the convolutions is flattened and œdematous, and lymph is found in all the sulci, matting them together; the cortical grey matter is usually red and congested; the underlying white substance of the centrum ovale is injected, numerous puncta cruenta being evident; the ventricles are distended with cerebro-spinal fluid, and the choroid plexuses contained within them are engorged with blood.

The **Treatment** consists in shaving the head and applying cold by means of an icebag or Leiter's tubes, care being taken that the application is continuous, and not intermittent. In the robust general venesection is useful, but in weaker individuals cupping or leeching may replace it. The bowels are freely opened and a bland diet ordered. The patient should be kept absolutely quiet in a darkened room, and every source of irritation and excitement removed. Even if recovery ensues, it is somewhat delayed, and similar precautions as to quiet, etc., must be maintained for some time. In the later stages, blistering of the scalp or neck, and the administration of mercury, are advisable.

Attempts have been made recently to relieve the symptoms, and determine a cure by means of operative measures, directed towards reducing the intracranial tension; the subarachnoid space has been opened below the tentorium, whilst others have utilized Quincke's plan of lumbar puncture. In no case of acute meningitis has a successful result followed, and when one considers the intricate character of the space to be drained, the fact that it is sure to be subdivided into separate cavities by deposits of lymph, and especially when it is remembered that the important fourth ventricle only communicates with the subarachnoid space through the small foramen of Majendie, which is certain to be early blocked—all these considerations go to prove that it is useless attempting any such measures.

Acute Meningo-encephalitis is sometimes *limited* in character, when resulting from open penetrating wounds. Such can only occur when there is no tension from retained discharges, diffusion along the meninges being prevented by the formation of adhesions. Localized suppuration is usually present, involving even the brain substance; but with care recovery may be possible, although an adherent cicatrix will be formed, giving rise possibly to subsequent epileptic symptoms.

(iii.) A **Subacute** form of meningitis is occasionally met with, coming on at a somewhat later date. The patient may have apparently recovered from his injury, with the exception of a localized fixed pain. The onset of the symptoms is often due to some indiscretion, and may be gradual or sudden. In all probability this affection is also microbic in origin, and the delay in its appearance depends either on the small number of bacteria present, or on their being in a low state of virulence; or possibly they have been lying latent for a time, and are aroused into a state of activity by later causes; or, again, they may have gradually worked their way inwards along lymphatics or vessels from the periphery to the meninges. The symptoms are similar in character to those of acute meningitis, though somewhat less severe; but a fatal result is very apt to follow. In the treatment of this form, no active antiphlogistic measures should be adopted, since the patient's condition is somewhat asthenic. Absolute rest and quiet is essential; counter-irritation should be applied to the scalp and neck, and possibly mercury administered.

(iv.) **Chronic Meningitis** may result from any injury of the meninges, and is especially likely to occur in syphilitic patients. It is evidenced by infiltration and thickening of the membranes, which are usually adherent to one another and to the cerebral cortex. It gives rise to a localized headache, which is constant, and increased on excitement or the injudicious use of stimulants, and it may lead to traumatic epilepsy. The treatment consists in attention to the general health, abstinence from excitement or stimulants, the local application of counter-irritants, and possibly the administration of mercury; the bowels must be kept regular, and if epilepsy ensues, and the lesion can be localized, trephining and removal of the cicatrix may be necessary (see p. 498).

(v.) **Cerebral Abscess** is occasionally seen in the later stages of head injuries, the pus forming deeply in the white substance. It may be looked on as a more or less natural sequence of any penetrating wound, whether a foreign body is present or not, the microbes finding their way into the interior of the brain either along the track of the missile or along bloodvessels or lymphatics. When, however, it occurs apart from penetration, one can only suppose that it is due to auto-infection of a contused or lacerated area. Chronic abscess of this type is most frequently seen on the same side of the brain as the lesion, and the parietal and frontal lobes are most often affected; occasionally, however, it may occur on the opposite side in the same way as a contusion. For treatment and symptoms, see Chapter XXI.

(vi.) In conclusion, one other form of intracranial inflammation must be mentioned, viz., **Infective Thrombosis of the Sinuses.** This, though seen after injuries, is more commonly associated with suppurative diseases of the bone apart from trauma, and one variety, viz., that affecting the lateral sinus, is almost exclusively caused by disease of the middle ear. It is also sometimes induced by extension from scalp injuries as a complication of subaponeurotic cellulitis, or may spread inwards from erysipelatous conditions of the face or suppurative conditions of the nose. Putting aside the results of chronic otorrhœa, the cavernous sinus is much more frequently involved than any other.

Pathologically, the same manifestations are observed as in any case of infective phlebitis. The infected sinus becomes impervious owing to the thrombus, and this in turn becomes disintegrated, and gives rise to multiple emboli, whilst various inflammatory conditions of the surrounding tissues necessarily result, *e.g.*, necrosis or caries of bones, subcranial abscess, or meningitis.

The *symptoms* generally are of a pyæmic nature. The temperature is high, but with remissions, and often with repeated rigors, whilst fixed headache and early and continuous vomiting are also marked features of the case. With these may be associated evidences of meningeal mischief, or of pulmonary trouble in the shape of dyspnœa, whilst sometimes diarrhœa and septicæmic manifestations may be the more prominent.

If the cavernous sinus is involved, marked exophthalmos, with congestion of the orbit, eye, and even of the eyelids and face, may result, and ptosis or squint may also be set up by implication of the nerves which lie in the walls of the sinus.

If the superior longitudinal sinus is affected, there may be turgescence of the veins of the scalp and forehead together with tenderness along the line of the sinus and epistaxis, whilst convulsions may be induced by irritation of the neighbouring motor area.

For local results and treatment of thrombosis of the lateral sinus, see Chapter XXV.

Treatment, except for the lateral sinus, is but rarely possible, and hence the importance of preventing this disease by a most careful attention to asepsis. For the lateral sinus much can be done, but for the other sinuses all that is feasible is attention to general measures.

Laceration of the Brain.—Injuries to the brain and its membranes are exceedingly common complications of blows and falls on the head, and all the most serious results of these accidents arise from this source. They are produced in a variety of ways, and cause many varied symptoms; but the most important distinction to draw is between those wounds which communicate with the exterior and those which do not.

I. **Non-penetrating Wounds of the Brain** result from blows and falls, which may or may not produce simple fissured or depressed fractures of the skull, but not uncommonly the most serious cerebral symptoms follow injuries in which the bones do not participate. In depressed fractures the brain is usually most contused or torn immediately below the injured spot; but in cases where there is no depression, the greatest mischief is frequently found at a point exactly opposite to that struck, whilst the local bruise may be much slighter. Thus, in the case of one of our students who, in an epileptic fit, fell striking the left occipital region on a stone pavement, we found post-mortem a fissured fracture at the spot struck, and a bruise of the left occipital convolution, whilst the anterior portion of the right frontal lobe was severely contused, and, indeed, disintegrated. The explanation of this fact is that the force of the injury is transmitted to the brain substance in a wave which concentrates its violence against the opposite side of the skull. In very sharp sudden localized blows, as from a spent bullet, local bruising of the subjacent brain may be alone produced.

Pathological Anatomy.—The *immediate* effects of such an injury vary considerably. There may be a mere bruise, evidenced by a few points of extravasation on the surface or in the substance of the grey matter; or the more superficial parts of the brain may be disintegrated and mixed with clots; or, if laceration has occurred, clots may be found adhering to the injured spot, or extending from it widely in the subarachnoid space, or even, under rare circumstances, extending into the lateral ventricle. The *later* effects in cases where the wound does not communicate with the exterior are mainly those of inflammation or degeneration. Soon after the accident considerable exudation follows, causing the ecchymosed brain substance to swell and become œdematous; this may speedily subside in the less severe cases, but in the more serious ones a *spreading œdema* may be caused, owing to the pressure of the swollen tissues upon the superficial veins in the pia mater; the circulation in these is hindered, and exudation follows, leading to general cerebral pressure, and even death, a consequence hastened by the excess of cerebro-spinal fluid usually induced by the process. Under such circumstances the greater part of the brain would be œdematous and glistening, the injured area being yellowish red in colour, with evident points of extravasation scattered through it. Still later degeneration of the brain substance may arise from the disturbance of its circulation, as indicated by the presence of a pulpy yellowish mass, soft enough to be washed away by a stream of water, and containing fat granules and granular cells, with débris of nerve fibres (*yellow softening*). If the area involved is small and unimportant, the patient may recover perfectly, the softened tissue being absorbed; if large or implicating important centres, death or paralysis must ensue. In cases of laceration of the brain which recover, a tough depressed cicatrix is formed, usually adherent to the membranes, and containing hæmatoidin crystals, whilst extravasated blood may be organized into a dirty brownish lamina, adherent to the pia mater, or into an arachnoid cyst.

Clinical History. — The symptoms necessarily differ with the severity and locality of the lesion.

Whenever concussion occurs after a head injury, and the patient recovers slowly after it, the surgeon will rightly suspect laceration or contusion of the brain.

If concussion is rapidly followed by the symptoms of cerebral irritation, there can be no doubt as to the existence of a laceration, which is probably situated in the frontal region.

If compression follows within twelve or twenty-four hours, it is either due to depressed bone or hæmorrhage into the cerebral hemispheres, if there is no interval of consciousness; but if the patient has rallied for a time before its incidence, hæmorrhage from the meningeal vessels or venous sinuses is to be diagnosed, or the existence of a rapidly spreading œdema.

If localized or general convulsions occur within twenty-four hours of the accident, perhaps going on to compression, hæmorrhage into the cortex of the motor area, or diffuse extravasation into the subarachnoid space, is probably present. It is not easy to distinguish between these two, but, as a rule, hæmorrhage into the cortex produces a more regular extension of the convulsions, which commence by twitching of some part of the body which is often at the time paralyzed. Thus, if bleeding is occurring into the cortical centres for the face on the left side of the body, paralysis of the right side of the face may be present, and it is here that the convulsions will start, spreading regularly to the right side of the neck, arm, and leg, and then involving the left leg, arm, and side of the head in order, finally becoming general, as in an epileptic fit. After each convulsion the paralysis is found to have spread. In hæmorrhage outside the convolutions the paralysis is less marked and the convulsions less regular, though perhaps more generalized, but compression symptoms develop sooner.

If compression comes on early, and is accompanied with hemiplegia, hæmorrhage into the corpus striatum or internal capsule is probably present, or perhaps into the ventricles.

In simple cases concussion is usually recovered from in a few hours; the temperature subsequently rises to about 100° F., and remains so for a few days, whilst the patient complains of fixed pain and headache, which under suitable treatment may entirely disappear. Some impairment of sense or function may, however, persist.

If subacute localized inflammation ensues, pain and headache will be complained of with some fever, and insensibility may supervene in four or five days, preceded by convulsions if the motor area is affected.

Suppuration in the white substance occasionally results at a later date in this form of injury, giving rise to the symptoms of cerebral abscess.

The **Treatment** of these cases is always an exceedingly anxious matter for the surgeon. In the majority of instances it is merely symptomatic, following the usual course adopted in concussion, compression, cerebral irritation, etc., as indicated elsewhere. The patient is kept absolutely quiet in bed, with an icebag to the head, and a purge administered. Depressed bone, if present, will, of course, be dealt with by operation. Early convulsions and paralysis will be carefully watched to see if any indication as to the site of the bleeding can be obtained, since it is possible that trephining over the injured spot and removing blood-clots might be advisable; but the clinical records as to such treatment are very scanty. Late convulsions and paralysis due to inflammation are best treated by shaving the head, applying an ice-cap, and leeching over the supposed site of the laceration. If the pulse is full and hard, and the patient otherwise young and healthy, general venesection may be adopted; the bowels must be moved by a smart purgative, such as croton-oil, whilst bromides in full doses may be administered. If the convulsions continue in spite of such treatment, and become more severe and extensive, the patient will almost certainly die of coma; trephining over the injured area is then distinctly indicated, the surgeon hoping to find and remove some clot, or, at any rate, to relieve tension within the dura.

II. **Penetrating Wounds of the Brain** may result from blows or falls, as in compound depressed fractures; or from the entrance of foreign bodies, such as bullets; or from stabs or punctures, which most commonly occur in the weaker parts of the cranium, *e.g.*, the temple or upper wall of the orbit; or from sabre-cuts or axe-wounds, in which an oblique or almost valvular incision is made through the scalp and cranium, laying bare and wounding the brain and its membranes.

In these cases the general disturbance is often slight, compared with the extent of the local injury, so that, although brain substance may protrude from the wound, there is sometimes but little concussion. Any of the conditions due to hæmorrhage detailed above may follow, but they will be less severely felt, except in cases where the bleeding is into the substance of the brain, since the blood can escape from the wound. The inflammatory phenomena following such wounds are mainly *septic* in origin, and may be localized or diffuse. In the latter instance diffuse meningo-encephalitis manifests itself in the course of two or three days, and is rapidly fatal; in the former case adhesions prevent the extension of the trouble beyond the neighbourhood of the wound. Hernia cerebri is very likely to follow, and not unfrequently a deep cerebral abscess will subsequently complicate matters. In cases that have been successfully rendered *aseptic*, the course is similar to that run by a non-penetrating wound, except that, if anything, the immediate prognosis is better, since the opening in the skull and the possible removal of damaged brain substance diminishes the likelihood of compression from simple or spreading œdema. Where the lesion has involved the motor area, permanent monoplegia may persist.

The **Symptoms** arising from a penetrating wound of the brain have been in measure indicated above. In the worst cases immediate death may result, or severe concussion, merging quickly into compression, from which the patient never recovers. In the less serious cases there will be a varying amount of concussion, followed after a short interval by the phenomena of inflammation, localized or diffuse, which have already been sufficiently described. Focal symptoms may also arise from destruction of the cortical centres.

Treatment.—In all cases of punctured or compound depressed fractures, we have already stated that a thorough exploration of the wound should be made, and all depressed or injured bone removed. Foreign bodies should also be taken away, if found close to the wound; but it is doubtful whether a bullet should be sought for, if it has penetrated deeply into the brain, or if it has traversed the brain and fractured the bone on the other side. Probably an aseptic incision, with removal of the splintered fragments and a limited search for the bullet, is the best treatment to adopt, and, even if unsuccessful, will do but little harm, if the patient's general state warrants an operation. When he is evidently moribund, it is better practice not to interfere. Protruding brain tissue is gently removed, and the whole wound thoroughly purified with carbolic lotion; even the 1 in 20 solution may be used without fear. The dura mater should, if possible, be drawn together by one or two sutures, and a small drain-tube or a gauze wick inserted within it. Fragments of bone, if kept warm and aseptic, may be replaced, as indicated above, and the scalp-wound closed, except at the drain opening; the gauze or tube should be removed, if all is going well, in about two days' time. If the temperature rises as a result of septic infection, the wound must be reopened, and every effort made to relieve tension, and thus localize the mischief. Should diffusion occur, as indicated by an increasing severity of the symptoms, the patient must be treated in accordance with the general principles already laid down for dealing with acute meningitis.

(In our description of lacerations of the brain we have purposely omitted any mention of the fact that symptoms may arise from inflammatory conditions affecting the bones. In actual practice the course of events is often considerably modified by such a complication.)

Localized Injuries to the Brain.

Thus far we have merely discussed the general symptoms arising from lacerations and wounds of the brain. We must now rapidly pass in review the special symptoms resulting from injuries of particular regions.

Upper and Middle Frontal Convolutions.—Neither motor nor sensory symptoms are noted, but cerebral irritation and subsequent weak-mindedness are likely to follow.

Third Frontal Convolution.—Motor aphasia, *i.e.*, the inability to produce or articulate words, results from lesions on the left side in right-handed individuals, and on the right side in left-handed people. Injury to the opposite convolution has no effect. If only one side is damaged, the other convolution can after a time be educated so as to take on the function of the damaged region.

The **Motor Area** (Fig. 163) is comprised of the ascending frontal and ascending parietal convolutions, respectively in front and behind the fissure of Rolando, of the posterior half of the third frontal convolution, and of the superior parietal lobule. The centres for the leg occupy the upper part of the ascending parietal convolution and the whole of the superior parietal lobule, those for the hip being in front, and for the feet and toes behind. The arm centres are located on either side of the middle of the fissure of Rolando, the shoulder being in front and above, and the hand and fingers below and behind; whilst the centres for the head, face, and lips are clustered together at the junction of the ascending and third frontal convolutions, the centre for movements of the angle of the mouth being highest, whilst the lowest part of the ascending frontal convolution governs the movements of the tongue and lips. Lesions involving any of these areas produce either spasm or paralysis of the appropriate region on the opposite side of the body.

Wounds of one **Occipital Lobe** may cause a temporary hemiopia, but no persistent loss of vision, unless the angular gyrus is also destroyed. Lesions of the latter region are always associated with permanent disturbances of vision.

The **Upper Temporo-sphenoidal Lobe** contains the cortical auditory centre, and lesions in this region cause deafness; the function of the middle and lower lobes is not yet ascertained with certainty.

Injury to the **Corona Radiata** leads to paralysis of the regions represented by the overlying cortex, but without convulsions; whilst if the corpus striatum or internal capsule is lacerated, as by hæmorrhage, hemiplegia, with perhaps hemianæsthesia, will result.

Wounds of the **Cerebellum** cause giddiness, vertigo, and ataxy, the patient reeling about, as if drunk, in a most characteristic manner.

A wound of the **Crus Cerebri** occasions more or less complete hemiplegia of the opposite side of the body, associated with total paralysis of the 3rd (oculo-motor) nerve on the side of the injury.

Laceration or contusion of the **Pons Varolii**, if not immediately fatal, may lead to paralysis of the opposite side of the body to the injury, together with paralysis of the 5th, 6th, 7th, or 9th nerves, on the same side as the lesion, constituting the so-called 'crossed paralysis.' Marked contraction of the pupils (myosis) may also be present.

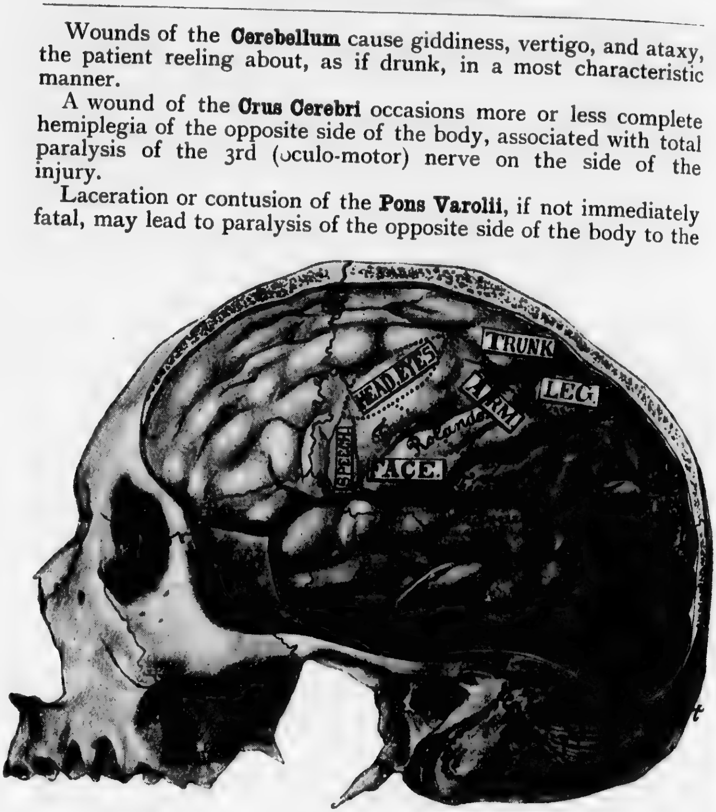


FIG. 163.—BRAIN AND CONVOLUTIONS IN SITU.

The fissures of Rolando and Sylvius are plainly indicated, and the situation of the chief motor centres. P. O. F., Parieto-occipital fissure; *t t*, level of tentorium with cerebellum seen beneath it. The position of the lateral sinus is also seen.

Wounds of the **Medulla** are usually fatal. If, however, the patient should escape, he is liable to suffer from disturbed functions of the circulatory and respiratory centres, with perhaps Cheyne-Stokes respiration and saccharine diabetes.

Cranio-Cerebral Topography.

The increased knowledge of the functions of the brain acquired in recent years, together with the diminution of the risks associated with opening the skull when asepsis is carefully attended to, has encouraged the surgeon to deal much more freely with cerebral conditions by operation than formerly. It is essential, then, that he should know what spots on the cranium correspond to fixed points on the cortex. We cannot do more in this work than give a diagram representing the relations of the convolutions to the sutures (Fig. 163), and, in addition, indicate the position of the two most important fissures, viz., those of Rolando and Sylvius, and how to mark out their situation on the cranium.

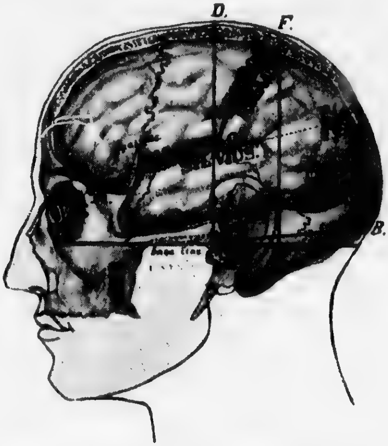


Fig. 164.—Diagram of Head to indicate Method of finding the Fissures of Rolando and Sylvius by Reid's Method. (After Reid.)

Sy. a. fiss., Anterior branch of Sylvian fissure; P. O. Fiss., Parieto-occipital fissure; *trans. fiss.*, transverse fissure along line of tentorium; A, external angular process of frontal bone; B, occipital protuberance; C D, anterior perpendicular in front of tragus; E F, posterior perpendicular through back of mastoid process.

The *Fissure of Rolando* may be found topographically by the following methods: (*a*) The upper extremity of the fissure is indicated by taking a point half an inch behind the centre of the line extending from the root of the nose to the occipital protuberance. The direction of the sulcus is downwards and forwards at an angle of about 67° to the middle line. This may be indicated by laying a strip of letter-paper over the skull, the long side corresponding to the middle line, and with its centre over the upper limit of the fissure; the anterior half is now folded over obliquely from this point, leaving an angle of 45° between the front of the paper and the middle line of the skull; and then the same process is again repeated, bisecting the angle and leaving one of about 67°, so that the anterior limit of the folded paper corresponds with the line of the fissure, which is about 3⅜ inches in length. (*b*) A more exact method is that defined by Dr. Reid, the measurements for which are all worked from the so-called Reid's base-line, which is one drawn on the skull from the lower margin of the orbit backwards through the centre of the external auditory meatus, reaching the middle line behind just below the occipital protuberance (Fig. 164). From it are drawn upwards two perpendiculars, one (C D) corresponding to the small depression in front of the external auditory meatus, the other (E F) to the posterior border of the mastoid process. The fissure of Rolando extends from the upper limit of the posterior vertical line to the point where the anterior line intersects the fissure of Sylvius.

The *Fissure of Sylvius* is indicated by a line drawn from a point 1¼ inches directly behind the external angular process of the frontal bone (Fig. 164, A) to a spot three-quarters of an inch below the most prominent part of the parietal eminence. The undivided portion of the fissure is represented by the first three-quarters of an inch, and from here the anterior limb (*Sy. a. fiss.*) rises vertically upwards for about an inch, whilst the posterior limb extends backwards for the rest of the line. If prolonged to the middle line behind, it indicates tolerably accurately the situation of the parieto-occipital fissure (P. O. Fiss.).

Hernia Cerebri.

By hernia cerebri is meant a protrusion of the brain substance through an *acquired* opening in the skull. It thus differs from an encephalocele, which consists in the protrusion of brain substance through some *congenital* defect.

It is always an evidence of increased intracranial pressure, and may be looked upon as Nature's safety-valve for the relief of compression. It is met with in two distinct forms:

1. When an opening has been made by the surgeon for the treatment of a cerebral tumour, which is subsequently found to be irremovable. The disc of bone is not replaced, and the brain substance protrudes through the opening under the scalp; by this means a temporary relief of intracranial tension is brought about, the patient's life prolonged, and possibly consciousness for a time restored. The tumour, however, continues growing, and sooner or later the patient dies comatose.

2. The other variety, due to a compound depressed or punctured fracture, is the result of sepsis in the underlying brain substance, and the increased pressure within the skull thereby induced leads to a protrusion of inflamed and œdematous brain matter through the wound in the dura, which is usually of small size. The tumour is soft and dusky in colour, and pulsates synchronously with the heart, the pulsations being often evident to the naked eye. It usually increases in size somewhat rapidly, and although the mental condition of the patient is at first unimpaired, sooner or later, if the condition progresses, coma is sure to follow, ending in the patient's death. The mass consists at first mainly of œdematous granulation tissue covered by blood-clot, without much brain substance, but later on brain tissue itself may protrude. The condition is usually fatal, though recovery is occasionally seen. **Treatment.**—Prevention of this affection must always be aimed at by endeavouring to render the wound aseptic and providing for drainage. Punctured wounds and depressed fractures of the skull, even when giving rise to no urgent symptoms, should always be operated upon, since free relief of tension may prevent a hernia cerebri from forming, even should absolute asepsis not be attained. If, however, protrusion occurs, it may be possible in a few cases to apply a dry dressing and elastic pressure, and thus prevent it increasing in size; this, however, must not be attempted when the inflammatory symptoms are at all marked. In such cases it is of little use to slice off the tumour and apply pressure, and possibly the best treatment that has been suggested is to apply absolute alcohol once or twice a day to the projecting mass; it is an efficient antiseptic, and also tends by its dehydrating power to diminish the size of the hernia. If such treatment is successful, the tumour slowly granulates over and cicatrizes. Traumatic epilepsy may, however, ensue.

Traumatic Epilepsy is the term applied to an epileptic condition resulting from injuries. It may arise from any of the following conditions: (1) A neuralgic and irritable cicatrix in the scalp; (2) a slight unrelieved depression in the skull; (3) excessive formation of callus after a fissured fracture, or chronic thickening of the bone from osteitis after a contusion, whereby the dura mater is pressed upon and irritated; (4) chronic meningitis, usually associated with an adherent cicatrix in the brain; (5) a single depressed spicule of bone projecting into the cerebral substance. A similar condition is seen apart from injury in consequence of irritative lesions of the dura mater or cerebral cortex, as, for example, from an osteoma on the inner wall of the cranium, or enlarged Pacchionian bodies. The **Symptoms** produced are epileptic seizures of the Jacksonian type, with or without a definite aura, according to the function of the part of the cerebral cortex which is involved. Localization of the lesion depends partly on the character of the aura, partly on the associated symptoms, such as a fixed headache, or the presence of a cicatrix. The **Treatment** is not particularly satisfactory. If there is any means of determining the site of the irritation, an exploratory operation is always justifiable, since some removable fragment or spicule of bone may be the cause of the symptoms. If, however, nothing is found except an adherent cicatrix between the membranes and the underlying brain, it is very questionable whether the surgeon should proceed further. In a considerable number of cases the cicatrix and surrounding brain substance have been removed; the fits have ceased for a time, but in almost every instance recurrence has followed sooner or later, owing to the formation of a fresh cicatrix at the site of operation. Moreover, permanent paralysis of the portion of the trunk governed by the removed cortical area has resulted, and hence the general opinion at the present time is that such an operation is unadvisable, except as a life-saving measure when the fits are extremely numerous and severe. Such a decision emphasizes the importance of the statement made before as to the necessity of dealing with all cases of simple depressed fracture in adults by operation. If it is decided that an exploration is desirable, the sooner it is undertaken the better, since the longer the epileptic habit lasts, the less favourable is the case.

CHAPTER XVII.

INJURIES OF THE SPINE.

The spinal column subserves a variety of useful functions in the body which causes it to be an exceedingly complicated structure, and exposes it to many forms of injury. Its primary object is to act as a pillar or axis of support to the trunk, connecting the distant parts of the skeleton together; this is effected by the massive bodies of the vertebræ piled one on the other, flexibility and mobility being at the same time secured by the number of bony elements of which it consists, and the interposed elastic cartilages. It also serves as a tube in which the spinal cord is safely lodged, whilst lateral openings are left between each of the bones to allow exit to the nerves passing to their peripheral distribution.

The spinal cord is protected from injury in a most complete and efficacious manner. (*a*) Its position between the bodies and the laminæ, with the spinous processes arising therefrom, is itself mechanically advantageous, since, whether the spine is forcibly flexed or extended, the cord remains midway between the points of chief compression or extension, and hence in a position of rest. (*b*) The buffer-like action of the intervertebral discs, and the varying curves of the column, serve to diffuse any violence reaching it, and thus reduce its force. (*c*) There is ample space in the medullary canal, in which the cord with its membranes is slung by prolongations of dura mater around the issuing nerves, whilst the cord itself hangs loosely within the dura mater, suspended by the ligamenta denticulata, and surrounded on all sides by cerebro-spinal fluid. (*d*) Moreover, the cord terminates, in an adult, at the lower border of the first lumbar vertebra, a spot well above the junction of the fixed base and the moveable upper part, a point where the effect of jars and wrenches is mainly felt. (*e*) Nature has, moreover, inserted a whole series of buffers and other means of preventing shock reaching the spine when a person falls on his feet, *e.g.*, the arches and elasticity of the foot, the changes in direction of the bones at each joint, the interarticular cartilages of the knee, etc.

The parts of the spine most exposed to injury are those where a fixed and moveable portion meet, *e.g.*, the dorsi-lumbar and the cervico-dorsal regions. The upper part of the dorsal curve, which is relatively weak and projects backwards, is thereby exposed to injury, so that fractures are not at all uncommon about the fourth dorsal vertebra. The close proximity of the head explains the frequency of lesions about the upper cervical region.

Sprains.

Sprains and strains of the spine are exceedingly common accidents, a fact not to be wondered at, when we consider the complicated muscular and ligamentous arrangements present. They may be produced by any sudden or unexpected movement, such as falls, especially from horseback, railway accidents, and the like. The injury is most likely to affect mobile parts of the spine, *e.g.*, the cervical and lumbar regions, and may be limited to the ligamentous or muscular structures, or may involve both. The resulting **Signs** are simply those of a severe but localized trauma, viz., pain, tenderness, bruising, and perhaps a little swelling; the subjective phenomena are much increased by movement, so that the spine is always kept rigidly quiet. If only the muscles or interspinous ligaments are involved, no further consequences will generally arise; but when the ligamenta subflava are lacerated, and the spinal canal is thus opened, the gravest symptoms may ensue from blood finding its way inwards to the canal outside the dura mater, leading possibly to paraplegia, which may be of a temporary or permanent nature, or even to death from asphyxia from pressure on the cord. Inflammation of the damaged fibrous tissues may also extend to the meninges and cord, and cause compression of the latter by the exudation, or even organic disease. Moreover, in patients of a tubercular temperament, spinal caries may be set up as a result of such injuries, whilst syphilitic or malignant disease has also been known to follow.

In the *cervical* region, sprains are very liable to occur as a result of severe blows on the head, causing tearing of the inter-transverse ligaments, and the displacement may be so great as to simulate dislocation. The head and neck are kept immovable and rigid, and there is often considerable loss of power, the patient being sometimes unable to lift the head spontaneously from the pillow. Sprains in the *lumbar* region are exceedingly common, both as the result of railway injuries, when they are often associated with nervous symptoms (p. 511), or as a consequence of overlifting, when the quadratus lumborum is most likely to be affected. The back is kept fixed and rigid, the patient being unable to turn or stoop without pain. Sometimes hæmaturia results from these injuries in the lumbar region, arising from contusion of the kidneys.

Treatment.—The patient should be kept at rest, and hot fomentations applied to the injured part. When the painful or inflammatory symptoms have disappeared, massage with stimulating liniments is needed. In the severer cases the individual should be kept in bed for six or eight weeks, and in the cervical region some form of mechanical support may be subsequently necessary. The appearance of inflammatory symptoms involving the meninges calls for greater care, and the patient should be kept as much as possible in the prone position, and a spinal icebag applied. The onset of paraplegia, due either to hæmorrhage or inflammatory exudation, would raise the question of laminectomy (p. 515). For hæmaturia, rest, as a rule, will suffice; possibly a few doses of tannic acid or turpentine may be beneficial.

Penetrating Wounds of the Spine.

These lesions are, fortunately, uncommon in civil practice, being generally due to stabs with pointed instruments, or to gunshot wounds. They occasionally result from falls, the unfortunate individual becoming impaled on area railings, branches of trees, etc. The **Symptoms** produced are (*a*) those due to the wound in the soft parts, which may also involve the peritoneal or pleural cavities, and may damage some of the viscera; in the neck, the vertebral artery is exposed to injury from this type of accident, leading to serious hæmorrhage; (*b*) those due to laying open the spinal membranes, *e.g.*, loss of cerebro-spinal fluid, which in itself might prove fatal by draining the cerebral cavity, and so causing pressure on the base of the brain, or at a later date may determine the patient's death by setting up diffuse septic meningitis (p. 510); and (*c*) those due to wounds of the spinal cord. The effects of a total transverse lesion at different levels of the spine are given at p. 514; if the patient escapes the dangers of diffuse septic meningitis, he will later on develop the signs of acute myelitis. Of course, the division of the cord may be only partial, or it may escape entirely. (*d*) In other cases, various forms of fracture may be produced, and the cord may be compressed by fragments of bone which have been driven inwards, or by extravasated blood.

Treatment consists in thoroughly exploring the wound under an anæsthetic, removing foreign bodies or displaced fragments of bone, and attempting to render it aseptic. Wounds of the vertebral artery or other structures are dealt with *secundum artem*, and special attention is naturally given to the cord and its membranes. Should the dura mater have been opened, and the cord have escaped injury, an attempt should be made to close the wound in the meninges, and the patient should subsequently be kept in the prone position, and with the head low, so as to prevent, as far as possible, the escape of cerebro-spinal fluid. If the cord itself is divided or lacerated, it is useless trying to unite it, since its function in conducting impulses from the brain downwards is inevitably destroyed. Where, however, the cauda equina has been injured, it is perfectly justifiable to lay open the spinal canal to a sufficient extent to expose the divided nerve trunks, and then to suture them together.

Fractures of the Spine.

Causes.—The spine may be broken as a result of (*a*) *direct violence*, *e.g.*, a fall on the back over some projecting body, such as a carpenter's bench or a railing, or a blow on the back with a heavy stone or with a swinging baulk of wood, or a gunshot wound. This type of accident may involve any part of the spine, and, excluding those arising from gunshot, is less frequent than the class next to be described. Of necessity, the spine breaks at the point struck; the posterior parts of the vertebræ are the most damaged in this form of injury. (*b*) Fractures are also due to *indirect* violence, then usually occurring in the lower cervical or upper dorsal regions. They are caused by forcible flexion of the spine, as by a fall downstairs with the head doubled up, or by taking a 'header' into shallow water, or when a man, being driven under a bridge, forgets to stoop, and so is caught between the arch and the cart, or sometimes by the fall of a heavy weight on the back of the neck, the spine bending and breaking at the weakest spot.

Fractures of the spine may be divided into two main classes, according to whether or not they are complete—that is, according to whether the continuity of the column is destroyed or not.

(A) **Incomplete Fractures** may be met with in various forms, and are most frequently due to direct violence.

(i.) *Fractures of the Spinous Processes* practically only occur in the lower cervical or dorsal regions. In the upper cervical region the spines are short and retracted to allow of extension of the head, whilst in the lumbar they are also short, but very strong. The fracture is almost always due to direct violence, and is characterized by the signs of a local trauma, together with great mobility, and perhaps crepitus, and irregularity in the line of the spines. The process is occasionally much depressed, and may even cause paraplegia by being driven into the spinal canal.

(ii.) *Fracture of the Laminæ* is a not uncommon accident, always resulting from direct violence. If only one lamina is broken, the signs are not very distinct, although the evidences of a local trauma exist, and possibly a little lateral mobility of the spinous process; cord symptoms in such are rare. When both laminæ yield, the posterior part of the neural arch, carrying with it the spinous process, is very likely to be depressed to a sufficient extent to compress the cord and give rise to paraplegia. Crepitus is often easily obtainable, and the gap in the line of the spinous processes can usually be readily felt.

(iii.) *Fracture of the Transverse Processes* is but rarely met with apart from other lesions of the spine, except as a result of gunshot injury.

(iv.) *Partial Fracture* through the bodies may occur in the form of fissures of the bones, which produce but little effects, except pain and rigidity, and cannot be diagnosed with certainty.

In any of these fractures where displacement is not present, paraplegic symptoms may arise, either immediately from concussion of the spinal cord, or later on from hæmorrhage or inflammatory effusions.

The **Treatment** merely consists in keeping the patient at rest for a time. The question of laminectomy for paraplegia, arising either from displacement of the laminæ or from hæmorrhage, will be discussed later.

(B) **Complete Fractures** are usually associated with displacement, and loss of continuity of the spinal column; they are often in consequence termed **Fracture - Dislocations.** They result either from direct or indirect violence. As a rule, there is a tolerably extensive lesion (Fig. 165); thus, the spinous processes and laminæ may or may not be fractured, the ligamenta interspinosa, supraspinosa, and subflava torn, the articular processes fractured in the lumbar and dorsal regions, or displaced without fracture in the cervical, and either the intervertebral substance torn across, or the bodies broken, thus severing the spine into two halves. The upper or moveable portion is usually driven forwards over the lower or more fixed fragment, and impaction or comminution is often present. The spinal cord is compressed between the upper end of the lower fragment and the laminæ of the upper fragment, and although the displacement may be naturally remedied by the falling back of the bones into position ('recoil'), yet the effects of the crush on the cord are usually irremediable. In slighter cases the spinal membranes may be merely punctured by a splinter of bone, or hæmorrhage may occur either within the membranes, or outside them in the fatty theca vertebralis. Excess of indirect violence may also lead to an associated fracture of the sternum.

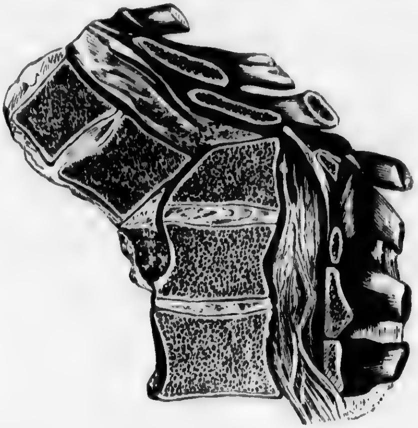


FIG. 165.—COMPLETE FRACTURE-DISLOCATION OF THE SPINE IN THE LOWER DORSAL REGION, WITH DISPLACEMENT AND COMPRESSION OF THE CORD. (AFTER KEEN AND WHITE.)

The **Signs** of this fracture are, as a rule, very evident, consisting of local pain, swelling, and bruising, and a certain amount of angular deformity, more or less according to circumstances. It may be possible to elicit crepitus, if the parts are not impacted, but as little manipulation should be used as possible, for fear of adding to the injury of the cord. Paraplegia below the part injured is probably present in all cases, and with it severe general shock. According to Erichsen, if the fracture is due to indirect violence, reflex movements will persist; but if due to direct injury, concussion of the spine is also present, and the reflexes will be absent. In cases where the cord is compressed, symptoms of spinal myelitis rapidly follow, and a fatal issue often occurs at an early date from toxæmia following septic cystitis or sloughing of the nates. The special phenomena of paraplegia are dealt with at p. 513.

The **Prognosis** of these cases turns largely on the situation of the injury and the amount of mischief sustained by the cord. The higher the lesion, the greater the danger, as a rule, although cases of cervical fracture with paraplegia may live for years, and such patients may even partially recover, if the cord has not been totally disintegrated.

The **Treatment** naturally varies with the character of the case. The patient is carefully placed in a prepared bed, the greatest gentleness being used in handling and lifting him, for fear of increasing the damage to the cord. The bed must be firm, though not hard, and is perhaps best made of horsehair mattresses placed over fracture-boards; nothing more soft or yielding is permissible. A water-bed is called for in the later stages, but should not be used at first, as it is scarcely firm enough. The shock resulting from the accident is treated in the usual way by warmth and stimulants, if need be; but it must be remembered that anæsthetic regions of the body can be easily blistered or burnt by hot-water bottles, unless carefully guarded by flannels. When reaction has occurred, a more thorough examination of the patient can be made, and the subsequent course of action decided on.

(*a*) In a small minority of the cases *operative treatment* is justifiable. We shall discuss later on (p. 516) the indications for laminectomy.

(*b*) When the displacement persists owing to impaction of the fragments, *reduction* under an anæsthetic may possibly be undertaken, provided that the lesion is not in the cervical region, and the paraplegia not complete. Of course, if other internal injuries are present which render the case hopeless, nothing should be done. Great care must be used in attempting reduction, since the object is to relieve pressure on the cord, and any undue violence may readily increase the mischief; in the lumbar region, however, considerable force may be employed without much danger. Whether reduction is accomplished or not, the further treatment must be directed in accordance with the indications given in the next paragraph. Where the surgeon fails to reduce the deformity, it may sometimes be advisable to make gradual extension from the feet or neck by the use of weight and pulley.

(*c*) In many cases, as soon as the patient is laid flat on a bed, the displacement remedies itself, especially if the spine has been comminuted, and then the treatment must be *symptomatic*, as also after reduction or operation, where the paraplegia persists or is only slowly recovered from. He is kept in bed, absolutely flat, and with the head low; perhaps some form of mechanical support, *e.g.*, a plaster of Paris or leather jacket, may be considered advisable; but its application is always a matter of some difficulty, and, at any rate, in the early stages it does but little good. Food is regularly administered, and at first must be light and readily assimilable.

The chief care of the attendants must be directed to the skin, bladder, and bowels. *Bedsores* are extremely liable to form on all points of pressure, and hence the nates and heels must be carefully guarded (p. 77); an excellent protective to the skin consists in a mixture of equal parts of liquor plumbi subacetatis and tincture of catechu, which may be painted on and allowed to dry so as to form a powdery film. In turning the patient to attend to the nates, the body must be rolled over as a whole, and not merely the pelvis twisted. It will often be found advisable to have a divided mattress placed beneath the pelvis, so that one lateral segment may be removed at a time, and thus rotation of the body will not be needed. A bedpan can also be used in this way without disturbing the spine. The *bladder* is probably paralyzed, and the urine must be withdrawn by a catheter. One of the greatest dangers that the patient runs is from the supervention of septic cystitis, and the extension of the inflammation upwards to the kidneys. This is always due to infection from without, and the greatest care must be taken to prevent it. The penis should be thoroughly purified, and in the intervals between instrumentation wrapped in an antiseptic or sterilized dressing. Only soft rubber catheters should be employed, and these must be kept absolutely aseptic by immersion in 5 per cent. carbolic lotion, or 1-1000 sublimate, which is subsequently removed before use by washing with a solution of boric acid. Should sepsis occur, the bladder is washed out twice daily with some mild antiseptic, such as Condy's fluid, boric acid, boroglyceride (1 in 20), or sanitas (1 in 20), whilst salol or boric acid in 10 grain doses may be administered thrice daily. Probably, in spite of all precautions, the condition will persist, and prove fatal from the resulting kidney mischief. The *bowels* are always obstinately constipated, and must be opened either by purgatives or simple enemata.

Under such a regime the patient may gradually recover, but more often succumbs to septic poisoning or emaciation. Occasionally he may live for a long time, although paralyzed, possibly developing some amount of reflex micturition, if the lumbar centres are not involved. Varying degrees of restoration of power in the lower limbs are also met with.

Dislocations of the Spine.

By dislocation of the spine is meant a displacement forwards, either partial or complete, of the upper part of the spine, with separation of the articular processes, and tearing of the intervertebral substance. A pure dislocation can only occur in the cervical region, and even then it is not uncommonly associated with a fracture; in the dorsal and lumbar regions it always takes the form of a fracture-dislocation. The reason for this depends partly on the immobility of the vertebræ in the latter regions, and partly on the direction of the articular processes. In the cervical region these look mainly upwards and downwards, with a slight slope forwards and backwards, so that it is not difficult for one to slip over the other; in the dorsal region they are placed nearly vertical, looking forwards and backwards, whilst in the lumbar they are also vertical, but look inwards and outwards, the lower enclosing the upper as in a sheath, so that in the last two regions of the spine dislocation is impossible without concurrent fracture of the articular processes.

Any part of the cervical region may be the seat of a dislocation. The *occiput* has been displaced from the *atlas* in a few cases, usually resulting in sudden death; but if incomplete, life has been prolonged for a few hours or days. Dislocation of the *atlas from the axis* has followed blows on the neck, or has been the cause of death in hanging, whilst the attempt to lift a struggling child by the head has sometimes led to this calamity. In almost all cases the odontoid process has been fractured, causing instant death from compression of the cord, owing to the head and atlas slipping forwards.

Dislocation may occur between any two of the *lower five cervical vertebræ*, but perhaps most frequently between the fifth and sixth. It is almost invariably the result of forcible flexion of the head and neck, and as a rule the intervertebral articulations are torn open, whilst the supraspinous and interspinous ligaments, the ligamenta subflava, and the anterior and posterior common ligaments, are lacerated, and the intervertebral substance torn across, or a scale of the articular surface detached. The head and upper portion of the spine are displaced forwards, so that the cartilaginous surfaces of the articular processes of the lower vertebra project behind the laminæ and transverse processes of the upper, and the lower articular processes of the upper vertebra lie within the intervertebral notch of the lower bone (Fig. 166, A and B, *a*). Two forms of dislocation are met with—the unilateral and bilateral.

(*a*) **Unilateral Dislocation** of the cervical spine is due to force applied from the back and side of the neck. The head is turned towards the opposite side, and more or less fixed, whilst there is no evidence of compression of the cord, although a tingling and neuralgic pain along the course of the nerves may arise from pressure upon and stretching of the nerve trunks in the intervertebral notch. The spinous processes may be irregular and displaced laterally, whilst the line of the transverse processes is similarly altered; such signs are, however, very difficult to make out in thick necks. If left unreduced, the vertebra becomes fixed in its new position, the head and neck displaced, and permanent neuralgia may result. In such cases, if seen early, *replacement* may be attempted. The patient is anæsthetized, the body fixed, the head and neck flexed, and then extended in that position, so as to unlock the edges of the articular processes. Reduction may be accomplished with a definite snap or catch. In old-standing cases an operation may sometimes be attempted to relieve pressure on the nerves, but it is impossible to replace the bones.

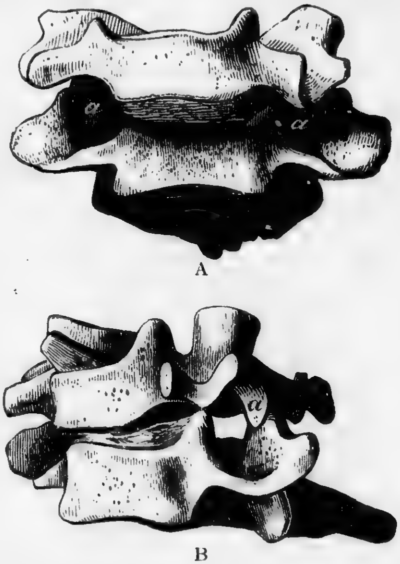


FIG. 166.—DISLOCATION OF THE CERVICAL SPINE. (AFTER KEEN AND WHITE.)

A, As seen from in front; B, side-view; *aa* indicate the lower articular facets of the upper or displaced vertebra, which are thus seen to lie in front of the upper articular processes of the lower vertebra.

(*b*) **Bilateral Dislocation** (Fig. 166, A and B), if complete, is always accompanied with pressure upon the cord and paraplegia; occasionally, however, it is only partial, and then the cord may escape without immediate injury, owing to the larger size of the canal in this region; hæmorrhage and inflammation may subsequently cause grave symptoms. **Treatment** is of but little avail in most of the cases of complete double dislocation, since probably the cord is irretrievably damaged; but where paraplegia is incomplete it is possible that benefit may arise from early interference. Replacement by means of extension of the head with the neck flexed may be first carefully tried, and failing that laminectomy should be performed. After stripping the muscles from the bones, the surgeon will see the two cartilage-covered surfaces of the upper articular processes of the lower vertebra standing out clearly behind the laminæ of the displaced bone. Extension of the head may now again be made, and reduction thus attempted; but if this does not succeed, as small a portion as possible of the upper margins of the exposed articular processes is excised in order to allow of the unlocking of the bones; if the whole processes are removed, reduction is much easier, but Nature's barrier to prevent a recurrence of the trouble has been taken away, and fixation of the spinal column in its natural position becomes impossible. The sudden relief of pressure not uncommonly causes such an interference with the intravascular tension in the cervical cord as to lead to a temporary cessation of the breathing, for which artificial respiration is required. It is usually advisable not only to replace the bones, but also to open the spinal canal and membranes, so as to relieve any pressure of blood or inflammatory exudation which may exist. The results of such operations are not particularly satisfactory.

Secondary Effects following Spinal Injuries.

Thus far we have limited ourselves to describing the immediate effects of injuries of the spinal column. Such, however, are frequently associated with, or followed by, other conditions affecting the cord and its membranes which may lead to the gravest results, even when the local lesion to the spine has been comparatively slight. These frequently run into one another in the most puzzling fashion, so that it is often difficult to state the exact nature of a certain group of symptoms; for simplicity's sake we shall discuss them here without attempting to describe the various combinations which may present themselves.

The following secondary effects may be met with after spinal injuries: (*a*) Direct spinal concussion; (*b*) spinal hæmorrhage; (*c*) spinal meningitis; (*d*) spinal myelitis; and (*e*) a series of phenomena which we shall discuss under the title of spinal neurasthenia (or railway spine).

Direct Concussion.—This condition may be due to severe blows in the back, which do but little damage to the spinal column, or may be caused by accidents which lead to the infliction of greater mischief, but without any serious displacement of parts. The term 'concussion' should be limited to those *cases where energetic traumatic influences (falls, blows, collisions, etc.) have given rise to* *severe disturbance of the functions of the cord without any considerable visible anatomical changes in the latter* (Erb). In fact, the term is really only applicable to those cases which recover more or less completely; if recovery does not ensue, minute extravasations or other lesions have been present, constituting a condition of contusion rather than concussion. It is somewhat doubtful, however, whether all these cases are not due to minute hæmorrhages.

The *Symptoms* produced are those of a more or less complete and immediate loss of function of that portion of the cord situated below the point struck. Thus, a varying degree of paraplegia is produced, the signs of which differ with the region affected (see p. 514). In addition, the patient is usually entirely prostrate from general shock to the system, and the reflexes are often totally lost—at any rate, for a time—as a result of the shock to the cord. Death may be caused at once by a blow in the upper cervical region, or varying degrees of loss of power and sensation may be produced in any or all of the limbs. In the lower cervical region the arms are mainly affected, and perhaps some particular nerve may be picked out and paralyzed. In the lumbar and dorsal regions a more typical paraplegia is produced, with loss of power over the sphincters, and loss of reflexes. Priapism never occurs in simple concussion. The temperature of the body may be depressed, and the extremities pallid and cold; the pulse is rapid and weak, and the respirations shallow.

The *Prognosis* is always uncertain, as in cases where there is no displacement it is impossible to gauge the extent of the mischief. If merely concussion is present, the patient is likely to recover; if the cord is contused, or hæmorrhage has occurred into its substance, a perfect recovery can scarcely be expected.

In the *Treatment* absolute rest to the spine is of the greatest importance, and this should be maintained if possible in the prone position, so as not only to diminish static congestion, but also to remove any pressure on the spine, and to allow topical applications to be made. A spinal icebag may be applied, or the back may be dry-cupped, whilst the patient is kept absolutely still, and on a low diet. The bladder and bowels need attention, but no special drugs are necessary. Of course, local injuries require local treatment.

Spinal Hæmorrhage.—We can here only discuss the subject of spinal hæmorrhage as resulting from injuries. It occurs also idiopathically, and it is interesting to note that such happens more frequently in young persons between the ages of ten and twenty than in old people, as with cerebral hæmorrhage. The bleeding may take place either into the cord itself, or outside it, and hence the two following varieties are described:

(*a*) **Intramedullary Hæmorrhage**, or spinal apoplexy, is met with as a result of injury, which need not necessarily damage the spine. Extravasation into the cord is rarely extensive, and may occur in the form of one clot, usually not larger than an almond, or more commonly in many spots, the grey matter being more or less ploughed up. Should the patient survive the injury for any length of time, secondary degenerations are established, and run the usual course. The patient is suddenly struck down with a more or less complete paraplegia, and with perhaps pain in the back, and to these are soon added the signs of a quickly developed transverse myelitis. The *Diagnosis* of hæmorrhage turns on the rapid onset of paraplegia without fever, and without spinal irritation. The *Prognosis* depends on the size and situation of the clot, a large clot producing more injury than a small one; hæmorrhage in the cervical region may be immediately fatal by interference with the respiration, whilst in the lumbar region it is unfavourable on account of the effect upon the sphincter centres. The outlook is best when the dorsal region is affected. The *Treatment* is the same as was indicated for direct concussion, whilst the administration of ergot may be beneficial.

(*b*) **Extramedullary Hæmorrhage** is a more common complication of spinal injuries, such as sprains or limited fractures, than the former. The blood is usually extravasated between the bones and the dura mater, especially in the cervical region, but may occasionally be found within the dura mater, having sometimes trickled down from the upper part of the column. The symptoms are, in brief, those of spinal irritation, *e.g.*, pain, hyperæsthesia, spasms, cramps, etc., rapidly followed by loss of power locally in the neighbourhood of the lesion, or by 'gravitation paraplegia' (Thorburn), which gradually extends from below upwards, causing death by asphyxia, the whole series of phenomena being afebrile. In intramedullary hæmorrhage the symptoms of paralysis are more evident, and those of spinal irritation less marked. If the diagnosis can be made, ergotin may be injected, and ice applied to the spine, or even laminectomy performed to relieve pressure; later on, prolonged rest may cause the absorption of the clot, and even total restoration to health.

Spinal Meningitis.—Inflammatory conditions of the spinal membranes may spread downwards from the head, or commence as a local affection. As a result of injury two forms are met with :

(*a*) In **Acute Spinal Meningitis** the inflammation mainly affects the arachnoid and pia mater (lepto-meningitis). It is usually general in character, and not unfrequently extends to the cerebral membranes. It may occasionally arise from simple injuries, but is most commonly septic in origin, following penetrating wounds. *Pathologically*, it is evidenced by hyperæmia and loss of polish of all the membranes, with excess of exudation; later on lymph, or even pus, may collect, especially about the posterior surface of the cord; should the patient live, organization of the effused lymph may lead to extensive adhesions. *Clinically*, the disease is usually ushered in by a rigor, especially in the septic cases, and will then run a marked pyrexial course. The symptoms are: pain in the back, deep-seated, boring, and severe, increased on all movements, and often extending down the limbs or around the body; rigidity of the spine and limbs, accompanied by painful cramps and muscular spasms, almost simulating a tetanic convulsion; marked hyperæsthesia, especially of the legs, and increased reflex excitability; whilst rapid emaciation from the pain and sleeplessness is soon produced. If the condition is limited to the spine, it is probably followed by signs of myelitis, *e.g.*, paraplegia, together with bedsores and vesical troubles, and these may lead to a fatal issue; cases, however, are met with which pass into a chronic state, and may more or less recover. If the process also involves the cerebral membranes, as in septic cases, the symptoms of diffuse cerebral meningitis are also present, and the patient dies from compression of the brain. *Treatment* in the cases due to a penetrating injury is of no avail if prevention of the disease by asepsis fails. In simple cases an icebag should be applied to the spine, the patient remaining in the prone position. Ergot and belladonna may be given internally, and general measures to allay inflammation adopted. The bladder and rectum must be attended to, and bromides and chloral may be administered to gain sleep.

(*b*) **Chronic Meningitis** is usually localized, and may occur either as an inflammation of the arachnoid and pia mater (lepto-meningitis), or be mainly limited to the dura mater (pachy-meningitis). It either originates as a chronic affection, or is the sequela of an acute attack. The membranes become hyperæmic and thickened, and adhesions between the cord and its membranes may occur. The extensions of pia mater into the cord readily explain the fact that a chronic sclerosing myelitis is frequently associated with this affection. The *Symptoms* are those of localized pain and rigidity in the back, increased on all movements, and accompanied by shooting pains and hyperæsthesia, and perhaps muscular pains and cramps. The reflexes are usually exaggerated, and vesical complications are likely to supervene. *Treatment* consists in prolonged rest, with counter-irritation in the form of blisters or the button cautery applied to the back, whilst mercury is administered internally.

Spinal Myelitis.—Inflammation of the spinal cord may follow injuries of the spine, either as a direct consequence of depressed or displaced bone, or from simple concussion or contusion with hæmorrhage; it may also ensue at a later date from extension of inflammation from the meninges, or from compression by lymph, pus, granulation or cicatricial tissue, or callus. It may be acute or chronic. In the former the cord becomes red and softened from hyperæmia and exudation; the nerve elements are destroyed, and finally replaced by cicatricial tissue if the patient live long enough. In the chronic cases the connective tissue becomes thickened, and the nerve structures compressed and disintegrated; in such there is almost always some associated thickening of the meninges.

Symptoms.—**Acute Myelitis** is evidenced by the presence of pain, hyperæsthesia, and muscular cramps in the earlier stages, soon followed by paralytic symptoms, if these are not already present as the result of the injury. The irritative symptoms are, however, much less marked than in acute meningitis. The reflexes are lost in the early stages, but soon become exaggerated below, whilst muscular atrophy is not especially rapid, except in those muscles formerly supplied from the affected area. The sphincters of both bladder and rectum are paralyzed, causing retention of urine and incontinence of fæces; the former is almost invariably followed by septic cystitis, especially when the trophic centres in the lumbar enlargement are involved. Bedsores are very liable to be produced, and may become very extensive and serious. Priapism and hyperpyrexia are often present when the cervical region is affected. The fatal issue is usually due to septic poisoning from the urinary tract, or perhaps from the bedsores.

Chronic Myelitis gives rise to a great variety of symptoms, but those most marked are a gradually increasing motor weakness, going on to paralysis, together with various sensory phenomena ending in anæsthesia, whilst there is trouble with the bladder and rectum, and perhaps bedsores.

The treatment of each of these conditions is mainly symptomatic.

Spinal, or Traumatic, Neurasthenia (*syn.*: **Railway Spine, Indirect Concussion of the Spine**).—Cases are not uncommonly met with in which, although there has been no direct injury to the spinal column or cord, and no immediate symptoms of importance, the fact is manifestly demonstrated in various ways that considerable commotion and disturbance had been produced in the nervous system. Railway accidents are the most common cause of this condition, but it may arise from any jar to the spinal column. The reason why railway accidents are so often responsible for this state is that the forces employed are very great, and the collision unexpected, so that the muscles and ligaments are taken at a disadvantage, being off their guard, whilst the shock, terror, and mental disturbance are also important factors. Ligamentous and muscular lesions—*i.e.*, sprains and strains—are the usual local phenomena produced by such accidents.

In the majority of cases the symptoms are mainly due to excessive irritability and weakness of the spinal and cerebral centres, constituting a condition of nerve prostration, or **Neurasthenia**, and the history will usually be somewhat of this type: The individual at the time of the accident is thrown from side to side, or severely shaken, but does not lose consciousness, and, although feeling somewhat dazed, is able to alight without help, and may even assist others. He perhaps continues his journey, and goes to his business, but finds in the course of a few hours that his back is painful, his head aching, and that he cannot apply himself to his work. He returns home and goes to bed, sending for his doctor, who will probably prescribe rest and bromides. His condition remains for a time unaltered; he complains of pain and tenderness over certain regions of the spine, especially in the lumbar, and is unable to walk, or to undertake any serious mental or physical effort, whilst all excessive sensory stimuli, such as a bright light or noise, are especially disturbing. Neuralgia may be present, whilst the pulse is weak, the urine may be retained or may dribble away, and the temperature be for a time subnormal. Accommodative asthenopia (or the inability to accommodate for near objects), resulting in a temporary condition of presbyopia, is also a marked feature in many of these cases. All the symptoms are aggravated by mental excitement and exertion, such as are often produced by the necessary interviews with doctors and solicitors pending the financial compensation by the railway company. The immediate improvement which often follows the satisfactory settlement of his claim for damages is not necessarily due to imposture, but may result from the removal of mental tension and anxiety.

This condition of neurasthenia may develop immediately after the accident, as an acute condition, the patient lying quite helpless and prostrate, or more often chronically, as in the more common type of cases described above. To it, however, is frequently added a considerable element of **Hysteria**, in the form either of acute attacks of hysterics, or of a chronic unconscious exaggeration of the sensory symptoms. If the patient is examined in the supposed hyperæsthetic area whilst his attention is distracted, possibly no pain will be complained of.

The *Prognosis* is, as a rule, favourable, the patient recovering perfectly after a period of rest and change, but in a few instances permanent effects may be produced.

In the *Treatment*, a good deal of care is needed to judge rightly when the period has arrived for encouraging movement rather than rest, and thus to prevent the patient from developing a condition of chronic invalidism. Rest in bed is to be recommended at first, bromides given in moderation, and hot fomentations applied locally. Later on, friction with liniments and massage should be employed, and when all chance of secondary inflammatory disturbance is at an end, movement should be encouraged, and change of air advised, whilst a course of strychnine and iron may be administered.

In a few cases, however, fortunately much rarer, the symptoms produced run on into those of a chronic low inflammatory condition of the spinal cord and its membranes, and these, to which Erichsen formerly applied the term **Indirect Concussion**, are of the gravest import. In others, nothing may be noticed by the patient for some weeks or months beyond the fact that he feels a little shaken, and not so capable of doing his work as formerly; but, at the same time, he loses flesh, and looks worn and fagged. Gradually other symptoms develop. His brain power is diminished, and any mental effort causes him to be muddled; the memory is defective, the temper irritable, and sleep much disturbed; the head is often hot. The vision is usually defective, and he complains of all sorts of noises in the ears. The sense of touch is impaired, so that all delicate movements are hindered. The spine is kept rigidly stiff, the head fixed, and the gait is somewhat unsteady and shambling; the walking powers are much diminished, and going up and down stairs is especially difficult. Motor power in all regions of the body is partly lost; any or every modification of sensation may be met with, whilst the reflexes are increased. The bladder may lose its power of retaining urine for a time, but this is not always a marked symptom; there is great impairment of both sexual desire and power. On examining the back, distinct tenderness is felt over one or more spots, especially in the lower cervical, mid-dorsal, and lumbar regions. In such cases, where the symptoms develop slowly, and remain unaltered by treatment, the *Prognosis* is most unfavourable, since they are probably due to low inflammatory changes in the cord and brain, and although the patient may live for years, yet he is permanently crippled, and becomes a confirmed invalid. *Treatment* in the earlier stages consists of rest, preferably on a prone couch, with counter-irritation, such as blisters, or even the actual cautery, over the spine, whilst mercury or iodide of potash, and bark, are administered. Careful nursing and massage of the limbs, or galvanism, are needed, and warm seawater douches may be most useful. If, however, no improvement follows, the patient must be encouraged to get about as best he can, and to go out in an invalid chair, so as to maintain the general health, whilst careful attention is directed to the personal hygiene.

Paraplegia.

Paraplegia arises in the course of spinal injuries from a variety of causes, which may be classified as follows:

1. **Paraplegia arising immediately after the accident**, from:
   - (*a*) Direct concussion without evident lesion, if such a condition be possible;
   - (*b*) Disintegration of the cord from intramedullary hæmorrhage or contusion without displacement of bone;
   - (*c*) Displacement of bones, with or without recoil, crushing the cord;
   - (*d*) Penetrating wounds dividing the cord.

However produced, the same symptoms manifest themselves if the lesion is complete; recovery is alone possible in the first and perhaps in the second group, whilst in the other forms the paraplegia is maintained by a subsequent acute transverse myelitis.

2. **Paraplegia arising after an interval**, from:
   - (*a*) Extramedullary spinal hæmorrhage, when the symptoms will show themselves without pyrexia in twenty-four or forty-eight hours;
   - (*b*) The pressure of inflammatory exudations, as in spinal meningitis, when the symptoms will be preceded by inflammatory phenomena, and will not appear before seventy-two hours at the earliest;
   - (*c*) The pressure of callus or of cicatricial adhesions around the cord and membranes (*i.e.*, peri-pachymeningitis).

It is unnecessary to discuss further the special signs and symptoms accompanying each form; they have been already mentioned under the appropriate headings. We merely propose to indicate briefly the effects of a total transverse lesion, and then to describe the results of paraplegia as they vary with the situation of the injury.

A Total Transverse Lesion, destroying absolutely one segment of the cord, will result in the following symptoms:

1. Paralysis of the muscular area supplied by the destroyed segment, followed by rapid atrophy, reaction of degeneration, and loss of reflexes.

2. Paralysis of all the muscles supplied by the segments below that which has been destroyed. The reflexes, after being temporarily diminished, become exaggerated, and the trophic condition remains normal, at any rate, for a time. When secondary descending degeneration in the antero-lateral columns has occurred, the muscles become contracted, tense, and rigid (late rigidity).

3. Complete anæsthesia of the sensitive area supplied by the destroyed segment, and of all the sensitive areas below.

4. A narrow zone of hyperæsthesia is found at the upper level of the anæsthesic area, due to the irritation of the nerve roots at the site of injury.

5. Vaso-motor paralysis combined with trophic disturbances in the parts which are paralyzed.

6. Visceral changes, especially in the bladder and rectum.

Phenomena of Paraplegia at Different Levels.

1. **At the Upper End of the Sacrum.**—Total transverse lesions at this spot are exceedingly rare; they only involve the cauda equina, and practically cause paralysis of the sacral plexus. The effects produced are: (i.) Paralysis of all the muscles of the legs, except those supplied by the anterior crural nerve, the obturator, and the superior gluteal, whilst the perineal and penile muscles are also affected. (ii.) Anæsthesia also involves the penis, scrotum, perineum, lower half of the gluteal region, and the whole of the legs except the front and outer part of the thigh, supplied by the cutaneous branches of the anterior crural, and the region supplied by the long saphena. (iii.) The bladder and rectum are both shut off from their spinal centres, and hence there will be temporary retention of urine, followed by distension with overflow, and incontinence of fæces. The bladder, however, gradually contracts, its walls become thickened, and its capacity steadily diminishes, so that incontinence becomes more and more absolute.

2. If the lesion is situated in the **Dorsi-lumbar** region, or passes through the lumbar enlargement, which corresponds to the twelfth dorsal and first lumbar vertebræ, there is complete paralysis of the muscles of both limbs, including those passing to them from the trunk; total anæsthesia of the legs, gluteal and perineal regions, and possibly the lower part of the abdomen; whilst, if the vesicle centres are destroyed, there is total paralysis of the bladder, with relaxation of the sphincter, dribbling of urine, which early becomes ammoniacal, and cystitis, due to trophic changes; if the centres escape, retention with overflow is the usual result; the rectum and sphincter ani are paralyzed, causing incontinence of fæces, the passage of which is unrecognised from the anæsthetic condition of the anus.

3. In the **Mid-dorsal** region the same phenomena are met with, but to them are added a more extensive region of anæsthesia, limited above by a hyperæsthetic zone, which feels like a tight painful girdle round the waist; paralysis of the flat abdominal muscles; retention of urine, followed by distension with overflow, which, however, may occasionally, when asepsis is maintained, be followed by a state of reflex micturition in which the patient passes water unconsciously and involuntarily, whenever there is sufficient present to cause sensory stimuli to ascend to the undamaged centres. The abdominal paralysis is a most important addition to the gravity of the case, for all straining movements are thereby prevented, and thus coughing is embarrassed and defæcation hindered. The gases developing from the

stagnant fæces accumulate and cause distension of the belly, and thereby respiration may be seriously impaired. The diaphragm, moreover, is hindered in its action, since the lower ribs cannot be fixed or steadied, and hence its contractions tend to pull them inwards, instead of increasing the dimensions of the thoracic cavity.

4. In the **Cervico-dorsal** region all these phenomena are present, but the anæsthesia extends over nearly the whole trunk, and hyperæsthesia may involve the arms, whilst the intercostal and spinal muscles are paralyzed in addition. Respiration has therefore to be carried out by the hampered diaphragm, with the assistance of a few of the accessory respiratory muscles in the neck, and hence is much impeded; any bronchitis present will prove fatal by asphyxia in a few days from the inability to expectorate. Priapism is a marked feature of cervical paraplegia.

5. In the **Lower Cervical** region the arms also become involved in both the paralysis and anæsthesia, and if the lesion be situated at or above the fourth cervical vertebra, instant death results from paralysis of the phrenics and consequent stoppage of the respiration.

Death from Paraplegia, therefore, may arise from a variety of causes and at various periods. It may be immediate, from respiratory failure in lesions above the fourth cervical vertebra; or it may occur from accumulation of mucus or pus in the air-passages, when the lesion is in the upper dorsal region; or it may be delayed for weeks, or even months, and then is due to sloughing of the nates, or septic absorption from an inflamed or ulcerated bladder, which is often associated with surgical kidneys.

The **Prognosis** and **Treatment** both depend on the position and character of the lesion causing the paraplegia, and on the previous habits and condition of health of the individual.

Laminectomy.

By laminectomy, or, as it used to be badly termed, trephining the spine, is meant an operation for the removal of the laminæ and spinous processes, in order to relieve pressure on the cord, whether due to depressed bone, abscess, granulation tissue, excessive callus, cicatrices, or tumours. The operation consists in making a longitudinal incision in the middle line of the back, extending to the spinous processes; the muscular and tendinous structures are then cleared from the posterior aspect of the vertebræ as far as the transverse processes, a proceeding usually attended with considerable hæmorrhage, which can be checked, perhaps, better by hot sponge pressure than by attempting to secure the individual vessels. The neural arches are then examined for injury, etc., and those which seem to be most affected removed by cutting pliers, Hey's saw, or laminectomy forceps. The posterior aspect of the membranes of the spinal cord is thus exposed, and the various conditions which may be met with are dealt with according to circumstances. In this place we have merely to consider the use of this operation after injury to the spine. For its use in other conditions, see Chapter XXIX.

Much controversy has arisen as to the value of this operation and the circumstances under which it may be justifiable, and we are beginning to discover tolerably accurately the limits of its usefulness. It must be remembered as a fundamental guiding principle that repair is impossible after the spinal cord has been divided, or any one segment totally disintegrated, and hence, if it is certain that a total transverse lesion of the cord has been caused by an accident, it is absolutely useless to operate. If, however, it seems likely that a portion of the cord has escaped, operation may be attempted, on the chance that when pressure has been removed sufficient cord substance may still remain to permit of some degree of functional repair. There will always be, therefore, a certain number of cases in which it will be a matter of doubt as to whether or not any benefit will accrue from the operation. The final decision under such circumstances will depend on the special predilections and opinions of the surgeon who is in charge of the case, and the general state of the patient.

Apart from these doubtful cases, the following are generally admitted as being suitable for operation: (1) For penetrating wounds or fractures with displacement of that portion of the spine below the first lumbar vertebra; the surgeon has only the cauda equina to deal with, and it is reasonable to treat it in the same way as one would treat any other peripheral nerve. (2) When the injury is mainly limited to the neural arch, which has been driven in by direct violence. (3) In all cases of bilateral dislocation of the cervical spine where the patient is not moribund. (4) When paraplegia arises with or without inflammatory symptoms after an interval has elapsed since the accident. The pressure in such cases may be produced by blood or inflammatory exudations, and benefit may possibly arise from the operation. If, however, it is due to a total transverse myelitis no good can result. (5) When symptoms of irritation or paralysis supervene at a later date, from contraction of cicatrices around the cord or its membranes (peri-pachymeningitis), or from excessive callus formation, laminectomy may be performed with good hopes of a successful result.

CHAPTER XVIII.

DISEASES OF BONE.

Inflammation of Bone.

In order to assist our readers to correctly understand the subject of inflammation in bones, we must call to mind a few facts relative to the constitution and growth of these structures.

Bones are divided anatomically into the long, the short, and the flat, each of these consisting of compact and cancellous tissue in varying amounts. In the short bones there is but a thin layer of compact tissue surrounding a cancellous central mass, the meshes of which are filled with medullary fat and connective tissue. In the flat bones the compact tissue forms two limiting plates, separated by a layer of cancellous tissue of varying thickness (known in the skull as the diploë). In long bones the shaft consists of a peripheral tube of compact structure, surrounding a space which is normally filled with medulla, and known as the medullary canal; at each end it gradually merges into a larger mass of loose cancellous tissue, the interstices of which are similarly packed with fatty medulla. It must be clearly remembered that there is normally no open hollow space, and therefore no endosteum or internal lining membrane (except in bones containing cavities, such as the mastoid process or frontal sinuses). The whole space is filled with vascular medulla, which apparently performs the function, not only of maintaining the nutrition of the bone, but also of elaborating the blood. Prolongations from the medulla, moreover, extend into the Haversian canals, and are thence continuous with the periosteum, so that the mineral skeleton has incorporated within it a vascular fibro-cellular mass which permeates its whole structure.

The *vascular supply* of a bone is derived (*a*) from the nutrient artery which passes into the medullary space, and there breaks up into branches which ramify through the whole of the medullary tissue, and thence extend into the Haversian canals; and (*b*) from the periosteum, an exceedingly vascular ensheathing membrane, from which small vessels pass perpendicularly into the Haversian canals, and thus establish a communication between the two systems. These latter vessels are especially numerous and large close to the epiphyses. Large veins occur in the medullary and cancellous interior, and are frequently thrombosed in inflammatory mischief; if the thrombus also becomes infected, and so disintegrated, pyæmia is very likely to ensue.

N.B.

The *growth* of bone manifests itself in three different ways: (i.) It increases in length from the shaft side of the epiphyseal cartilage, the epiphysis itself growing but little. In the upper limb the chief increase in length occurs at the shoulder and wrist, whilst in the leg it is mainly evident on either side of the knee-joint, and this in spite of the fact that the so-called nutrient arteries are directed away from these points; this would tend to indicate that the importance of these vessels in supplying nutrition to the bones has been much over-rated. (ii.) Increase in breadth is produced by new formation of bone from the deeper layer of the periosteum, which contains many yellow elastic fibres, and a large number of angular nucleated cells, or osteoblasts, which are presumably the bone-forming agents. (iii.) A bone increases in density by a new deposit of osseous tissue around the Haversian canals and cancellous spaces.

In considering the inflammatory affections of bones, it must always be kept in mind that the essential pathological phenomena (viz., hyperæmia, exudation, and tissue changes, active or passive) are similar to those manifested in any other vascular structure, but that the resulting effects are modified by the limited space in which the vessels lie, and the resisting character of the surrounding osseous tissue. Hence any *acute* inflammation resulting in rapid vascular engorgement, and considerable exudation quickly poured out, leads to *necrosis* from thrombosis, due to increased pressure within the unyielding bony canals. If, however, the process is *subacute*, so that the tissue-liquefying properties of the exudation and the tissue-absorbing activity of the leucocytes can come into play, then *osteo-porosis* or *rarefaction* of the bone results, a condition sometimes termed *caries*. On the other hand, if the inflammation is *chronic*, and due to causes other than tubercle or the pressure of tumours, then new formation occurs, and *osteosclerosis*, or condensation, is most likely to result. Tubercle in bones, as elsewhere, causes primarily rarefaction of the tissue attacked, though sclerosis may be associated with or follow it, and the chronic pressure of tumours or aneurisms leads to rarefaction and atrophy locally, although a certain amount of sclerosis may be induced around.

One more general fact must be noted, viz., that it is very rare for any inflammatory process to affect solely one element of a bone. The continuity of the vascular supply explains why a periostitis is usually or almost invariably associated with inflammation of the subjacent bone, and why an osteo-myelitis is never purely and simply limited to the medullary cavity.

Terminology.—Many different terms have been applied to these pathological processes, and much needless confusion introduced thereby into a subject at all times somewhat complicated. Especially is this the case in inflammatory affections of cancellous or compact bone, the terms 'osteitis' and 'osteo-myelitis' being used with very little precision. All inflammation of bone occurs in connection with the vascular tissue permeating its structure, and hence, as this is everywhere connected with the medulla, all such processes might be described as forms of osteo-myelitis. This term is, however, limited to the affections of the medulla of long bones, whilst the term 'osteitis' is applied to those occurring in the compact tissue of the shaft of long bones, or in the cancellous tissue at the ends of long bones, or in the interior of short bones, and with such limitations we shall comply here. Then, in addition, the results of disease are often confounded with the pathological processes leading to them, and the clinical conditions—*caries*, *necrosis*, and *sclerosis*—are described as distinct diseases; we shall endeavour to avoid this source of error by prefacing our description of the diseases with a few remarks on each of these clinical conditions.

Necrosis, or death of bone, may occur in a variety of forms, and from many different causes, *e.g.*: (*a*) From acute localized suppurative periostitis, the sequestrum, or dead mass, being then simply a superficial plate or flake of the compact exterior (Fig. 167); (*b*) from acute idiopathic infective osteo-myelitis (acute panostitis or acute necrosis), the sequestrum then often involving the whole thickness of the bone, and invading more or less of the length of the diaphysis, so that a greater extent of the superficial tissue is destroyed than of the cancellous interior (Figs. 168 and 169); (*c*) from acute septic osteo-myelitis, usually traumatic in origin, the sequestrum being annular in shape, and involving more of the interior of the bone than of the exterior (Fig. 170); (*d*) from acute or subacute septic osteitis of cancellous bone, the sequestra being small spiculated fragments of the bony cancelli which have escaped absorption by the granulation tissue always forming in such a process; (*e*) from tubercular disease of cancellous tissue, the sequestrum being light and porous, often infiltrated with curdy débris, and rarely completely separated from surrounding parts; (*f*) from syphilitic disease of cancellous or compact tissue, usually resulting from excessive sclerosis, or gummatous disease of the periosteum which has become septic; (*g*) from the action of local irritants, *e.g.*, mercury, or phosphorus fumes gaining access to the interior of the teeth; (*h*) occasionally as a simple senile loss of nutrition.

The *separation of sequestra* is always brought about by a process analogous to that by means of which sloughs and gangrenous materials are cast off from the body, viz., by complete absorption if small, aseptic, and surrounded by sufficiently vascular tissue; by absorption of as much as possible, in larger aseptic masses, granulation tissue invading and replacing the dead mass, and a line of separation forming as a result of defective nutrition of the most advanced layer; or, if septic, an active rarefying inflammation occurs in the neighbouring living tissue, which in time breaks down, and so sets free the dead mass. (See in more detail at p. 65.) From the eroding action of the granulation tissue, the under surface of the sequestrum is always hollowed out, and, as it were, worm-eaten in appearance. Where sepsis is present, the process is more active, and is completed more rapidly, though with greater risk to the patient.

Caries, or, as it is sometimes called, *osteo-porosis*, or *rarefaction of bone*, is a clinical condition resulting from inflammation, characterized by a soft and spongy state of the bone, which, if it can be reached, readily breaks down on pressure with a probe. It may result from the following conditions: (*a*) A simple subacute inflammatory process, *e.g.*, during the early stage of repair in a fracture, or as a consequence of the pressure of tumours, etc.; (*b*) from acute or subacute septic or infective inflammation of cancellous tissue; (*c*) from tubercular affections of the cancellous tissue or periosteum; (*d*) from syphilitic disease of the under surface of the periosteum or of the medulla.

Pathologically, it is characterized by the replacement of the normal medulla by granulation tissue, which usually contains some large multi-nucleated cells, or *osteoclasts*, which seem to be closely connected with the removal of the bone, though we are at present in ignorance of the manner in which this is effected. The cancellous tissue becomes hollowed out to accommodate these granulations, and the osteoclasts are usually found occupying shallow depressions known as 'Howship's lacunæ.' In tubercular and syphilitic lesions the bone corpuscles undergo fatty degeneration.

Certain terms are used to indicate the characteristics observed in particular cases. By *Caries sicca* is meant that the process occurs without suppuration; in *C. suppurativa* pus is always present; in *C. fungosa* the granulation tissue is exceedingly abundant, especially in tubercular disease of the articular ends of bones; in *C. necrotica* necrosis is associated with caries, the sequestra consisting either of spiculated fragments, or in tubercular disease of larger masses.

If caries is recovered from, a subsequent condition of sclerosis usually ensues, with loss of substance, and often considerable deformity.

Sclerosis of bone (osteo-sclerosis) is invariably the result of some chronic inflammatory affection, *e.g.*, (*a*) chronic periostitis, whether simple or syphilitic; (*b*) chronic osteo-myelitis, simple, tubercular, or syphilitic; or (*c*) chronic osteitis of the compact bone, which is always secondary to one of the former. In all cases the condition is due to a slow formation of new bone within the Haversian canals or cancellous spaces, thus diminishing their lumen; in syphilis this may progress to such an extent as to lead to their total occlusion, and even to localized necrosis from lack of blood-supply, especially where sepsis has occurred. In tubercular bones the sclerosed tissue is always at some distance from the focus of mischief, and may be looked on as Nature's attempt to limit the spread of the disease; and it forms also the final tissue or bone-scar in the process of repair in those cases where a cure has been obtained by natural or surgical means.

Classification of Inflammatory Affections of Bones.

I. **Periostitis**:
  (*a*) Acute localized, with or without suppuration.
  (*b*) Chronic simple, or hyperplastic.
  (*c*) Chronic tubercular.
  (*d*) Chronic syphilitic.

II. **Osteitis**, or inflammation of *compact* bone, which is always associated with and secondary to either periostitis or osteo-myelitis, and so will not be described separately. The acute form results in necrosis, the subacute in osteo-porosis, and the chronic in sclerosis, except in tubercular disease, or when due to the pressure of tumours.

III. **Osteo-myelitis**, or inflammation of the medulla of long bones:
  (*a*) Acute septic (traumatic).
  (*b*) Acute infective (idiopathic = acute panostitis).
  (*c*) Subacute simple or infective, *e.g.*, after fractures, or during the separation of sequestra, resulting primarily in rarefaction, but finally in sclerosis.
  (*d*) Chronic simple, tubercular or syphilitic, usually causing general enlargement and sclerosis of the bone, even if locally some rarefaction is present.

IV. **Inflammation of the Cancellous Tissue** (**Osteitis**) may similarly be:
  (*a*) Acute septic or traumatic.
  (*b*) Acute infective.
  (*c*) Subacute simple or septic.
  (*d*) Chronic simple, syphilitic, or tubercular.

When limited to the articular end of a bone in a young person, this is sometimes termed **Epiphysitis**.

It is unnecessary to describe in detail all these conditions, since many of the divisions overlap each other, and hence we shall group together the various acute and chronic affections in order to indicate the clinical signs and symptoms.

ACUTE INFLAMMATIONS OF BONE.

1. **Acute Localized Periostitis** usually arises as a result of traumatism applied directly to the bone, with or without an open wound; it may also be determined by general conditions, such as rheumatism, gout, and pyæmia, or by an extension of inflammatory mischief, as in an alveolar abscess.

Pathologically, the process consists of hyperæmia of and exudation into the periosteum, which becomes swollen, turgid, and thickened. This may be followed in due course by resolution, or may leave the bone thickened and in a condition of chronic inflammation; or suppuration may ensue, and with it usually a limited superficial necrosis. In the last event pyogenic organisms must find an entrance to the area of mischief, and probably in cases due to trauma through the abraded or injured skin; in other instances they may come from neighbouring foci of inflammation, or possibly auto-infection may occur. Whatever their origin, these organisms are not usually very virulent, or, at any rate, they rarely give rise to much serious mischief. The inflammatory process extends to the small vessels entering the bone from the under surface of the periosteum; these become first dilated, next thrombosed and strangled by the pressure of the exudation around them, and finally pulled out from the osseous canals by the tension of the subperiosteal effusion and by the peptonizing

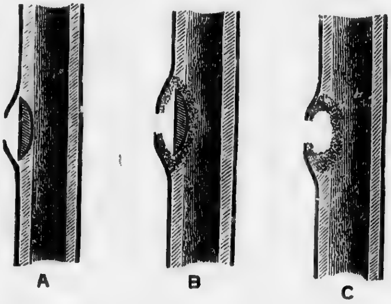


FIG. 167.—SUPERFICIAL NECROSIS RESULTING FROM A LOCALIZED PERIOSTITIS (DIAGRAMMATIC).

A represents the necrosed tissue lying in continuity with the surrounding living bone; the periosteum is stripped up from it, and has an opening through which the pus has been evacuated. B shows a later stage, in which the sequestrum is being separated by a process of rarefying osteitis in the immediately contiguous living bone, whilst an involucrum, or sheath of new bone, is formed from the under surface of the periosteum; a cloacal aperture remains in the involucrum for the escape of discharges. C shows the condition of affairs after the sequestrum has been removed.

power of the bacterial products. Consequently, the vitality of the superficial layer of the bone is destroyed for an area corresponding almost exactly to that from which the periosteum has been stripped (Fig. 167 A).

As soon as tension has been relieved by evacuation of the pus, either by Nature or the surgeon's knife, repair commences. In some cases where the mischief is very slight and superficial, the involved bone may entirely recover, or even small necrotic portions be absorbed. If the dead portion of bone is more extensive, it will be separated from the subjacent living tissues by one of the processes already described (p. 519), whilst from the under surface of the stripped-up periosteum a casing of new bone is developed, constituting an *involucrum* or sheath, at first spongy and cancellous in texture, and finally becoming hard and sclerosed. In the centre of this new formation are found one or more openings or *cloacæ* through which the discharge passes, and corresponding in position to the openings in the periosteum and skin made by Nature or the knife (Fig. 167, B).

Clinically, the symptoms of acute localized periostitis consist in the ordinary signs of an acute inflammation, the pain being of an intense aching character, markedly worse at night, and increased by lowering the limb or by any kind of pressure. If a subcutaneous portion of bone is involved, a painful swelling is felt, at first brawny in character, but, when suppuration has occurred, the centre softens, whilst the skin over it becomes red and œdematous. When an abscess has burst or been opened, bare bone is felt beneath the periosteum, and the greater part of this denuded structure usually dies, and must then be either absorbed or separated, in any case a sinus remaining for a time communicating with a cloaca in the involucrum. From this either pus or serum will be discharged, according to whether the wound has become septic or not. In about five or six weeks' time the sequestrum is loose, and this may be ascertained by moving it with a probe within the osseous cavity, which is now lined on the inner aspect with granulation tissue.

Treatment.—Rest, elevation of the limb, leeches, and hot fomentations are usually relied on locally in the early stages, whilst a good purge and specific anti-diathetic remedies may be used generally. If, however, the affection is not readily checked, and suppuration threatens, a free antiseptic incision down to the bone is the best means of preventing necrosis. Should an abscess form, it must be opened early, and possibly by this means death of the bone may be obviated or limited. When necrosis has occurred, the parts must be carefully dressed and kept aseptic, until the sequestrum is detached. An incision is then made over the involucrum, the periosteum stripped from it, one of the cloacæ enlarged, and the dead bone removed. The cavity will now rapidly fill up with granulations, and heal completely. In many cases recovery may be expedited by chiselling away those portions of dead bone which must ultimately be separated without waiting for the tardy process of Nature; this should not be undertaken until the destructive changes have ceased and the cavity become sterile, and, of course, only to a limited extent. The dead bone is recognised from the living by its white appearance and by not bleeding when cut.

2. **Acute Infective Osteo-myelitis** (*Syn.:* **Acute Necrosis, Acute Diffuse or Infective Periostitis, Acute Diaphysitis, Acute Panostitis**).—This disease usually occurs in children, often of a tubercular inheritance, and not unfrequently follows one of the exanthemata (*e.g.*, measles or scarlet fever). It generally commences before the age of puberty, and is an affection of the gravest import. Although often idiopathic in origin, it may result from some slight injury, which under other circumstances would do but little harm.

Pathology.—The patients are always in a state of depressed general health, so that their germicidal powers are considerably diminished. Moreover, spots of localized ulceration are often present in the throat, mouth, and intestines, which give a ready entrance for micro-organisms into the system. Evidently some of these must be circulating within the blood, ready to attack any area of diminished tissue resistance. A slight injury, which is often entirely overlooked or forgotten, may suffice to determine the commencement of an inflammatory process which rapidly spreads by continuity of tissue, until the whole structure of the bone may be affected.

The disease almost always starts in the soft vascular tissue on the shaft side of the epiphyseal cartilage, but it may be preceded by a patch of localized periostitis in the diaphysis. The medulla becomes intensely hyperæmic, culminating in localized foci of suppuration and gangrene. The veins become thrombosed, and, in consequence of the increased pressure, infective emboli are likely to be detached, and pyæmia to follow. Even if the latter does not occur, the general condition is profoundly affected by the absorption of toxic products from the inflamed tissues. Suppuration also occurs beneath the periosteum, which is rapidly stripped up from the diaphysis, and this may even spread to such an extent as to involve the whole length and circumference of the shaft. Unless prompt measures are taken to limit the progress of the disease, necrosis is certain to follow, usually implicating the whole thickness of the diaphysis, and sometimes extending along its whole length.

The *organism* generally found in this disease is the *Staphylococcus pyogenes aureus*, but occasionally others are responsible for it, and the symptoms vary somewhat with the causative microbe. Thus, if due to the *Staph. pyog. albus*, the process is less acute; a good deal of brawny infiltration of the periosteum ensues, and necrosis is more easily prevented by early treatment;

this variety is sometimes termed 'periostitis albuminosa.' The *Streptococcus pyogenes*, if present at all, is only found in young children, and the resulting necrosis is often less extensive. The *pneumococcus* has also been discovered in this disease, as well as the *Bac. typhosus*, but with each the inflammatory process is subacute in nature. One special characteristic of typhoid necrosis is the length of time the organism may lie latent in the medulla before leading to suppuration. The *Bac. coli communis* has only been demonstrated in association with other organisms; the resulting pus is very foul.

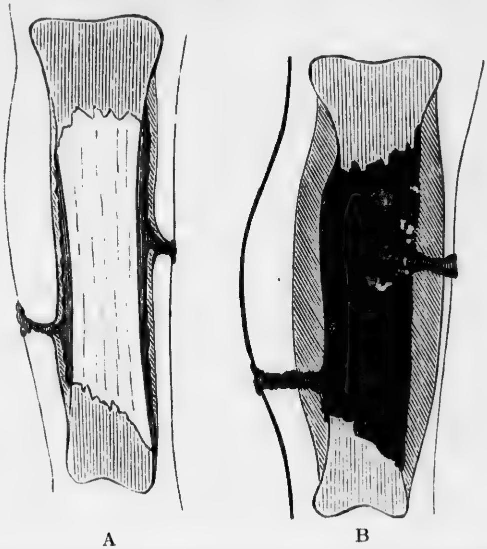


FIG. 168.—DIAGRAM OF MASSIVE NECROSIS AFTER ACUTE OSTEO-MYELITIS. (BILLROTH.)

In A (early) the necrosed tissue, though continuous above and below with the healthy bone, is surrounded by a cavity formed by the stripping up of the periosteum, and from it two sinuses pass to the exterior; in B (late) the sequestrum is supposed to have been loosened and removed, and the cavity remaining is lined by granulation tissue, and surrounded by a thick involucrum of new bone, in which two cloacæ exist.

Clinical History.—The disease usually commences abruptly with a rigor, followed by high fever and severe pain in the limb, which soon becomes swollen, brawny, and congested. It may at first be mistaken for an acute attack of rheumatism, although the fact that the interarticular portion is affected, and not the articulation, should readily prevent this error. The periosteum is early stripped from the bone, and an abscess forms beneath it which may extend along the whole length and around the whole circumference of the diaphysis, being usually, however, limited by the close attachment of the periosteum to the epiphyseal cartilages. Owing to this, neighbouring joints escape without being involved in the suppurative process, unless (as in the hip-joint) the epiphyseal junction is intra-articular, or the disease attacks the epiphysis and burrows through it (*vide* epiphysitis), or unless the suppurative process spreads along the soft tissues outside the bone, as along the bicipital groove into the shoulder-joint. A serous effusion into the joints is, however, often a concomitant symptom. Occasionally in the most severe cases both epiphyses are detached, and the whole diaphysis may be found lying free in an abscess cavity formed by the stripped-up periosteum. Moreover, the process may at times be so acute as to cause actual sloughing or disintegration of the periosteum, so that subsequent repair is impossible. The formation of the abscess is always accompanied by severe constitutional disturbance of a toxic or pyæmic nature, and the patient's life may be destroyed in this way.

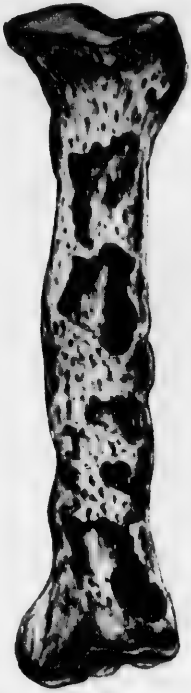


FIG. 169.—NECROSIS FOLLOWING ACUTE OSTEOMYELITIS. (FROM SPECIMEN IN COLLEGE OF SURGEONS' MUSEUM.)

The irregular new bone of the involucrum is well seen, and within it portions of the sequestrum.

Sooner or later the subperiosteal abscess, which may have transgressed its periosteal boundary and burrowed under fascial or muscular planes, is opened or bursts externally, giving exit to a larger or smaller amount of pus, and the subjacent bone is found bare and apparently dead. Possibly the relief of tension may suffice in such cases to limit the mischief, the periosteum again becoming adherent to the bone, and thus a cure established without extensive necrosis. More frequently a considerable portion of the shaft loses its vitality, and has to be separated in the manner already detailed, whilst an involucrum forms around it from the periosteum (Figs. 168 and 169). If sepsis has been excluded, no fever or bad constitutional symptoms need be expected during this stage.

The **Prognosis** is always somewhat grave. Life may be threatened by pyæmia or toxæmia in the early stages, whilst later on hectic, amyloid disease of the viscera, and exhaustion, may terminate the case if sepsis has been admitted.

The utility of the limb is subsequently unimpaired if the disease has not been too extensive, and if prompt treatment has been adopted; but if neighbouring joints are affected by a suppurative arthritis, or if the osteogenetic powers of the periosteum have been destroyed by the acuteness of the process, amputation may be required. In cases which have recovered, excessive growth of the bones will often follow, owing to the long-standing hyperæmia of the part; but if the epiphyseal cartilage has been much affected the limb may be stunted in its subsequent development.

Treatment.—Prompt surgical interference must be adopted in order, if possible, to cut short the malady. As soon as the local pain and high fever give evidence that this affection is present, a free incision should be made in the long axis of the limb through the periosteum, whether suppuration exists or not. The surgeon will then proceed to carefully investigate the condition of the bones by inspection and the use of the finger and probe, and his further proceedings will to a large extent depend upon what is thus found.

If the suspicions as to the existence of osteo-myelitis are thereby confirmed, the most vigorous surgical treatment is demanded, for if the teachings of pathology are to be depended on, it is certain that no good can follow any half-measures which stop short of the medullary canal. As a rule, the surgeon will find himself in the neighbourhood of the epiphyseal cartilage, and if the case has been taken in hand early, it is possible that the mischief will be quite limited; all that is then required is to scrape or gouge away the softened and hyperæmic bone at the end of the diaphysis, together with any necrotic tissue which may be present. The cavity thus formed is thoroughly washed with an antiseptic, and perhaps swabbed out with pure carbolic acid; a drain-tube is inserted, and in all probability recovery will rapidly ensue.

If the case has gone further, the periosteum will be found stripped from the bone for a varying distance, and possibly the epiphysis partially or completely separated. Under these circumstances it is always necessary to open up the medullary canal by removal of part of the compact bone, so as to allow the hyperæmic and gangrenous fatty tissue contained therein to be scraped out. Whether or not it is advisable to remove a portion of the whole thickness of the shaft must depend on the exact condition of affairs in the particular case. Certainly when the lower end of the femur is attacked, and grave constitutional phenomena are associated with loosening of the lower epiphysis of the femur, it will often be found expedient to amputate, since resection, even if successful, may leave a shortened and useless limb, for it is a well-known fact, although no very satisfactory explanation of it has as yet been vouchsafed, that in necrosis of the posterior aspect of the lower end of the femur there is scarcely any attempt at the formation of an involucrum.

If the periosteum has been more extensively involved, and a large amount of bone, possibly the whole diaphysis, denuded, two courses are open to the surgeon: either to remove the whole necrosed area at once, or simply to relieve tension and wait for an involucrum to form before taking away the sequestrum. The great advantage of the former plan consists in the immediate extirpation of the infective focus, thereby diminishing the risks of pyæmia or toxæmia, and preventing the necessity for further operative proceedings. On the other hand, it is claimed that the continued presence of the sequestrum is beneficial, in that it stimulates the periosteum to new formation of bone, and hence it should not be removed until a sufficient involucrum has formed. The practice usually adopted is as follows: For the femur and humerus sequestrotomy should be delayed; immediate removal would lead to hopeless shortening and crippling of the limb. For the bones of the forearm or leg, immediate removal is perfectly justifiable, since there is always a second bone present to maintain the length of the limb. Some surgeons have recommended that a bone-graft or suitable rod of celluloid or ivory should be inserted to take the place of the resected diaphysis and stimulate the osteogenetic powers of the periosteum; there is no objection to such an attempt being made, provided that asepsis is maintained, but it is very questionable whether any good will follow.

When there is any doubt as to the actual condition of the bone, its immediate removal is undesirable; the pus is allowed to escape through a free incision, the cavity is well irrigated, and the stripped-up periosteum allowed to fall back upon the bone, and regain adhesions to it, if possible. Drainage is provided for, and the strictest attention to asepsis maintained. Under such a regime, the wound soon becomes sterile, and the discharge merely serous. A portion of the bone usually dies, and during its separation from neighbouring parts becomes incased in a newly formed involucrum. When the sequestrum is free, *sequestrotomy* will be called for; it consists in reflecting the periosteum from the new casing, and in enlarging or uniting one or more of the cloacæ, so as to allow the sequestrum to be withdrawn; it sometimes expedites matters to divide the sequestrum into two portions, and then to deal with each separately. The cavity thus left is well irrigated, and either drained or packed with gauze, so as to allow it to heal from the bottom by granulation. Occasionally the operation for removal of the sequestrum is exceedingly difficult and dangerous, owing to the situation of the sinuses, and in some places, *e.g.*, the posterior aspect of the lower end of the femur, it is almost impossible to reach it. Under such circumstances *amputation* may be preferable. This summary proceeding may also be called for in the course of this disease, on account of pyæmia, defective repair, exhaustion from chronic sepsis, or suppuration in a neighbouring joint.

3. **Acute Epiphysitis** is the term applied to an infective inflammation of an epiphysis, similar in nature and origin to the acute osteo-myelitis just described, and most often affecting the upper end of the humerus, or one or other end of the femur. This disease is almost entirely limited to infants and very young children, and is said to occur more frequently in the subjects of inherited syphilis. It commences most frequently on the shaft side of the epiphyseal cartilage, but its effects are mainly limited to the epiphysis, which may become eroded, carious, or sometimes even necrosed, whilst the shaft is but slightly involved. Suppurative arthritis may be caused, especially if, as in the hip-joint, the epiphyseal cartilage lies within the cavity of the articulation; or an abscess may form and burst through the articular cartilage into the joint. The local and general phenomena are identical with those described as characteristic of the former disease, and the treatment consists in free incision, if possible before suppuration occurs, removal of the infected tissue, and drainage. Death from exhaustion and pyæmia is very likely to ensue.

A *subacute* or chronic variety of this affection is also met with in young adults (constituting one form of 'growing pain'), in which the same symptoms present themselves, but by suitable treatment resolution is obtained without suppuration or necrosis. In such cases, however, the subsequent growth of the bone at the epiphysis may be impaired or even arrested.

4. **Acute Septic Osteo-myelitis** arises as a result of infection from without, *e.g.*, in cases of compound fracture, and after amputation, excision, or even osteotomy. The organisms present are usually staphylo- or strepto-cocci, together with various non-pathogenic varieties. The clinical history of a case involving the shaft of a long bone is as follows: The patient during an attack of septic traumatic fever following an injury or operation has one or more rigors, which suggest the existence of pyæmia, and is suddenly seized with severe pain in the limb, which becomes intensely sensitive. On examining the wound, the soft parts are found to be unhealthy and infiltrated, the lower end of the bone is bare and yellow, and from the interior projects a stinking mass of gangrenous medullary tissue. Should early and efficient treatment not be undertaken, the patient runs a considerable risk of succumbing to pyæmia or septic intoxication, whilst a varying amount of the interior of the bone necroses (*central or tubular necrosis*), and a small segment of its whole thickness below, so that the sequestrum which ultimately separates is annular and conical (Fig. 170). Should the patient survive, the necrotic tissue gradually separates, and during this process a mass of new bone is formed from the under surface of the periosteum, so that the shaft

becomes much thickened externally. Hectic fever may supervene whilst this is occurring.

The **Treatment** of this condition has been somewhat modified of late years. Formerly, the only plan adopted was amputation of the limb through the next joint. At the present time one would freely open up the wound as early as possible, flush it out, and then thoroughly scrape away the sloughing medullary tissue from the interior of the bone, subsequently disinfecting the cavity with pure carbolic acid, and placing a drain-tube or gauze wick in it for a few days. A certain amount of necrosis may follow, but without high fever or signs of sepsis. Should this treatment fail, amputation may still be resorted to, but probably at a lower level than would otherwise be necessary.

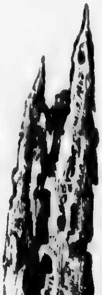


Fig. 170.—Tubular or Conical Sequestrum from Septic Osteo-myelitis after Amputation.

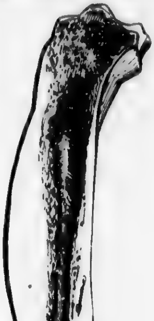


Fig. 171.—Chronic Osteo-periostitis of Tibia, showing the Fusiform Swelling on the Front of the Bone, consisting of Dense Osseous Tissue, and the Medullary Cavity encroached upon by the Sclerosis.

A similar process may also invade the short bones, and the cancellous extremities of long bones, being often secondary to septic arthritis, or to a compound fracture involving such parts. The local and general phenomena are very similar to those detailed above, except that no large sequestra are formed, the dead bone coming away in small spicules (one form of caries necrotica). *Treatment* consists in free drainage, removal of the septic tissue and efficient purification of the wound.

We have also seen one or two cases of *subacute septic osteomyelitis*, involving the shaft of long bones after operation, in which the medulla became profoundly altered in texture, being transformed into granulation tissue, with rarefaction of the bony cancelli; the process was associated with considerable pain and some amount of constitutional disturbance. No necrosis followed, but amputation was necessary on account of the extent of the disease and the pain.

CHRONIC INFLAMMATION OF BONES.

Chronic Osteo-periostitis.—By this disease is meant a chronic inflammatory condition of the bone, which results in overgrowth, thickening, and condensation.

Varieties.—(*a*) It may arise as a *localized* chronic periostitis, traumatic, rheumatic, or syphilitic in origin, or due to the close proximity of a chronic ulcer; it is characterized by a formation of new bone beneath the periosteum, known as a *node* (Fig. 171). The cancelli are arranged at right angles to the surface, in consequence of the new tissue forming around the small vessels, which enter the bone from the under surface of the periosteum. At first this new material is soft and spongy, but it rapidly becomes hard and sclerosed, and a similar condition affects the subjacent compact structure, which becomes thickened and indurated by a new formation around the Haversian canals. If the irritation persists, as in the case of a chronic ulcer, this condition may run on into the following variety:

(*b*) The *diffuse* form of chronic osteo-periostitis usually originates in some deep-seated or central affection, tubercular or syphilitic in nature, and tends to involve the whole bone, although it is sometimes limited to one or other end. If tubercular, there may be a small abscess or some central necrosis, and around this focus of prolonged irritation the bone becomes thickened and indurated. In the later stages a considerable new formation may occur beneath the periosteum, and even the medullary canal become entirely obliterated. If syphilitic in origin, it may be due to a central gumma, or a general condition of sclerosis may supervene without any special focus.

The **Symptoms** consist of deep aching pain in the limb, worse at night, with perhaps tenderness over some particular spot. This latter condition is especially evident in cases where a localized abscess exists in the head of a bone, such as the tibia. On examination the bone is felt to be thickened, and its surface more or less nodulated. If the disease is localized and superficial, a distinct node may be felt, consisting of a hard, fusiform, and tender swelling. Where the enlargement is more general, there is less tenderness, though the pain is constant.

The **Diagnosis** of such cases is not always easy, the enlargement of the bone being sometimes mistaken for the early stage of a malignant tumour. The slower rate of growth of the latter, its more defined limits, and the irregular tension of the mass, are the most characteristic features; but an exploratory incision is often needed to settle the question.

The **Treatment** at first consists in resting the limb, applying counter-irritation (*e.g.*, iodine paint or the actual cautery), and giving iodide of potassium internally. If relief is not thereby obtained, the operation of *linear osteotomy* should be practised. The limb is best ex-sanguinated, and an incision made over the whole length of the thickened bone, right through the periosteum. This membrane is now stripped aside with periosteal detachers, raspatories, etc., and if merely a nodular enlargement is present, the new formation is freely chiselled away. When the whole thickness of the bone is involved, a free opening or trench must be made by gouge and mallet, extending into the medullary cavity through the whole length of the enlargement. The soft parts are then partially drawn together and the wound dressed. It is advisable to cover it with protective, so that the hollow made by the surgeon may fill with blood-clot, and this is then allowed to organize (p. 196). If this operation is carefully performed under antiseptic precautions, and enough bone is removed, the most satisfactory results may be expected. In some of the most aggravated conditions, which have lasted for many years, amputation may be required.

Tubercular Diseases of Bones.

Bones may be affected in two ways by tubercle, either the periosteum or the cancellous tissue being primarily involved.

1. In **Tubercular Periostitis** a specific infiltration of the periosteum is met with, consisting of a deposit, partly in that membrane and partly under it, of pulpy granulation tissue containing the characteristic miliary tubercles, which are chiefly developed around the vessels passing from the periosteum into the bone. As in tubercular disease elsewhere, caseation and suppuration are likely to follow, leading to the formation of abscesses which are primarily subperiosteal, and filled with curdy pus; these in time find their way to the surface, either directly or by more or less tortuous channels, and leave sinuses, extending down to the bone. The final effect of such a condition depends largely on whether the subjacent bone consists of thick or thin compact tissue. If the compact bone is *thick*, the disease is usually localized to the part first affected, the surface of the bone escaping entirely, except some slight superficial erosion. Occasionally, however, the disease may spread along the periosteum for some distance, and even

involve a neighbouring epiphysis or joint. If the compact bone is *thin*, as in the bodies of the vertebræ, the underlying cancellous tissue is certain to be secondarily affected, and the changes to be immediately described are produced.

Clinically, the symptoms consist in a localized swelling of the bone, together with the characteristic form of pain associated with chronic osseous disease, but not so severe as in the deeper varieties. If a superficial bone, *e.g.*, the tibia or ulna, is attacked, a nodulated swelling is produced, of somewhat unequal consistency, and irregular in shape; it is not so hard as a simple node, whilst on firm pressure small portions may be felt to give way. If an abscess forms, the pain becomes greater, but it diminishes again as soon as tension is relieved by evacuation of the pus.

Treatment.—Whether suppuration has occurred or not, the condition usually demands incision, free removal of all the granulation tissue and softened bone with a Volkmann's spoon, disinfection of the cavity with pure carbolic acid, and stuffing it with gauze soaked in an emulsion of glycerine and purified iodoform (10 per cent.), the wound being allowed to granulate from the bottom. The extent to which the bone should be scraped away is often indicated by the fact that the nearest layer of unaffected bone is hard and sclerosed, whilst, if no sclerosis is present, the healthy tissues are redder and bleed more freely. In the early stages of this disease, constitutional treatment may suffice, together with rest and carefully adjusted pressure.

2. **Tubercular Osteitis** always arises in cancellous tissue, and it affects the short bones, or the shafts or ends of long ones.

The *short* bones of the hands and feet are very liable to this condition. It occurs in weakly children with a tubercular inheritance, or in those whose general health has been depressed by one of the exanthemata, or sometimes in those otherwise healthy. Some slight injury may determine the onset of the attack. When the phalanges are involved, the disease is known as **Tubercular Dactylitis** (a condition formerly described under the meaningless title of 'spina ventosa').

Clinical History.—The affected bone becomes slowly enlarged, expanded, and painful, the pain being, however, slight in amount, though generally worse at night. This continues for some time, until finally one spot rapidly increases in size, becoming red and tender, and finally an abscess forms, which bursts or is opened, leaving a sinus, down which a probe can be passed into the carious interior of the bone. Occasionally contiguous joints are also involved in this process.

Pathology.—There is a deposit of tubercle bacilli in or around the bloodvessels in the interior of the bone, which may have been previously rendered somewhat hyperæmic as the result of an injury. The organisms produce their usual effect, viz., transformation of the normal medullary tissue into pulpy granulation tissue containing tubercles, the bony cancelli becoming meanwhile eroded and rarefied, and the bone corpuscles undergoing fatty degeneration (*vide* Caries, p. 520). Sequestra occasionally form, but more often in adults than in children, owing to the greater density of the bone in the former. They are due to a cutting-off of the blood-supply of a definite portion of the bony tissue, either as a result of tubercular endarteritis, or from early caseation within the cancelli of the whole of the granulation tissue. The sequestra are usually yellowish white in colour from the presence of the caseating tissue in their substance, and are seldom completely separated from the surrounding bone; thus, they are often quite clear superficially and laterally, but adherent on the deeper side. When the tubercular disease does not involve the whole bone, the nearest healthy tissue usually becomes sclerosed, and thus one not unfrequently finds a central sequestrum surrounded by rarefied bone which merges into an area of sclerosed tissue. When a tubercular focus becomes septic, the destructive process increases in rapidity, and minute spiculated sequestra often come away in the discharge. The term *expansion* of bone used above is perhaps scarcely correct, inasmuch as the enlargement is due to absorption on the inner aspect, whilst there is a new formation of bone under the periosteum. Fig. 172 represents a skiagram of a thumb affected with this disease.

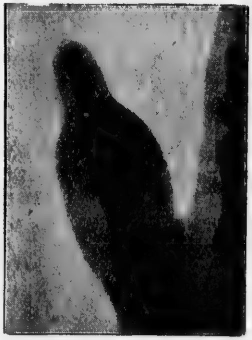


FIG. 172. — SKIAGRAM OF TUBERCULAR DACTYLITIS, SHOWING THE EXPANSION OF THE BONE TOGETHER WITH A CERTAIN SMALL AMOUNT OF PERIOSTEAL THICKENING.

The **Treatment** of tubercular dactylitis in the early stages consists in attention to the general health, together with rest locally, and perhaps strapping the parts with Scott's dressing. Should the disease progress in spite of such measures, an incision down to the bone should be made at some suitable spot where tendons or other important structures will not be injured; the periosteum is divided, and the outer layer of compact bone removed by gouge or trephine, so as to allow the diseased medulla to be scraped away with a Volkmann's spoon. When all the tubercular tissue has been eliminated, the cavity thus produced is swabbed out with pure carbolic acid, and stuffed with gauze soaked in an iodoform emulsion, in order to obtain healing by granulation. Unless this scraping is thoroughly performed, recurrence is very likely to ensue. When an abscess or a sinus exists, the same measures must also be adopted.

Any of the short bones in the tarsus may be involved in exactly the same manner, and the clinical history and treatment are identical, although possibly articular lesions are somewhat more common than when the disease is limited to the phalanges. As a general rule, a cure can be brought about by scraping if it is performed sufficiently vigorously; thus, the whole of the interior of the os calcis can be scooped out in this way, the cavity being ultimately filled by a mass of fibrous tissue, although a marked permanent depression always remains at the site of operation. Decalcified bone chips mixed with iodoform have been packed into the cavity in order to hasten bony consolidation, but not with much success. When the disease has progressed so as to involve neighbouring joints, amputation may be called for (see Diseases of Joints of Foot, p. 577).

If the tubercular disease affects *the ends of long bones*, it most commonly starts on the shaft side of the epiphyseal cartilage. The changes already described take place, and lead to early destruction of the cartilage, so that the adjacent parts of both epiphysis and diaphysis become involved (**tubercular epiphysitis**); more rarely the disease starts in the epiphysis itself, or immediately beneath the articular cartilage. The general signs are similar to those present when the smaller bones are involved, but the results produced may vary considerably. (i.) In the slighter forms, where efficient treatment is adopted, the tubercular tissue may be totally absorbed, and the process thus comes to an end. (ii.) In others it may be circumscribed by the bone becoming sclerosed around a caseating focus, and then, if suppuration ensues, a *deep abscess in the end of the bone* may be produced (Figs. 173 A, and 174). Such is rarely of large size, containing at most 1 or 2 drachms of curdy pus, and is lined by a definite pyogenic membrane of the usual tubercular type. The effects

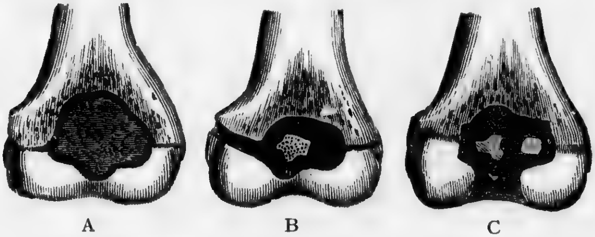


FIG. 173.—DIAGRAMMATIC REPRESENTATION OF THE RESULTS OF TUBERCULAR EPIPHYSITIS.

In A the focus has become encapsuled, a chronic abscess in the interior of the bone resulting: in B the process has tracked along the epiphyseal line, opening externally without involving the joint; a sequestrum has also formed: in C the epiphysis has been invaded and destroyed, and the joint freely opened; two sequestra are indicated.

produced by this condition are similar to those of chronic osteoperiostitis, viz., a deep aching or boring pain in the bone, worse at night, together with enlargement of the affected part, whilst often one spot may be exceedingly tender on palpation. If it has existed for any length of time, the whole shaft may become enlarged (p. 531). (iii.) The disease may burrow along the epiphyseal line, and find its way into the neighbouring joint, if the epiphysis is intra-articular, as in the hip; but if the epiphyseal cartilage is placed beyond the limits of the capsule, a subperiosteal extra-articular abscess will result (Fig. 173, B). Should the disease spread equally in all directions, the epiphysis may actually be separated. (iv.) A more common result is for the whole or part of the cancellous tissue of the epiphysis to become involved, and the joint to be secondarily affected with tubercular arthritis, either by perforation, erosion or necrosis of the articular cartilage, or by extension to the synovial membrane around its margins (Fig. 173 C). (v.) The process may sometimes extend upwards along the medulla into the shaft, causing a diffuse osteoperiostitis with or without a medullary abscess.

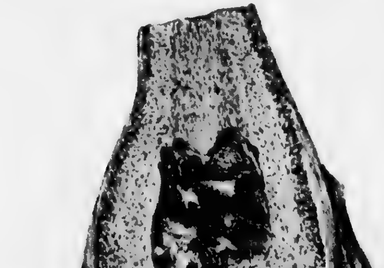


FIG. 174.—LOCALIZED ABSCESS IN THE LOWER END OF THE FEMUR, EXTENDING FROM THE EPIPHYSEAL LINE UPWARDS INTO THE MEDULLA. (FROM SPECIMEN IN THE COLLEGE OF SURGEONS' MUSEUM.)

The **Treatment** of tubercular epiphysitis is conducted along the same lines as for tubercular disease elsewhere, but the surgeon must not be tempted to trust too long to palliative measures, for fear of the joint becoming also affected. As soon as possible, an opening should be made into the interior of the epiphysis, and all the pulpy granulation tissue, caseous debris, or diseased bone removed with a sharp spoon, the cavity being subsequently disinfected, and stuffed with gauze infiltrated with iodoform. Where a chronic abscess exists, a trephine should be applied over the tender spot, and, if the cavity is not at first opened, the end of the bone may be drilled in different directions to ascertain whether or not pus exists.

The *medullary canal* of the shaft of a long bone sometimes becomes the seat of tubercular disease; but this, as also the abscess of bone described above, is more common in adults than in children. The part thus affected becomes carious, with or without the formation of sequestra or pus; but the most marked feature of this deep-seated central trouble is that the whole bone passes into a state of chronic inflammation, which we have described, as well as the treatment necessary for it, under the title of chronic diffuse osteo-periostitis (p. 531).

Syphilitic Diseases of Bones.

The osseous tissues may be involved in acquired syphilis in either the secondary or the tertiary periods.

In the **Secondary Stage** flying pains about the bones (sometimes termed osteocopic) are often complained of; they are, however, of but little importance, and disappear rapidly as the patient gets under the influence of mercury. In the late secondary or early tertiary periods, a *periosteal node* is often met with, as a result of chronic periostitis. It usually affects only one bone, and most commonly the tibia, and consists at first of an infiltration and thickening of the periosteum, which may be entirely recovered from, but later on is accompanied by a formation of new bone. This is at first spongy and soft in character, but after a while becomes hard and sclerosed; the Haversian canals are always placed at right angles to the subjacent osseous tissues. When such has once occurred, absorption of the newly formed bone does not readily follow, even under treatment, the part perhaps remaining permanently thickened. It is recognised clinically as a fusiform swelling, perhaps a little tender on pressure, and the seat of deep aching pain, usually worse at night. It must be understood that the pain is not so much associated with the onset of night as with the increased warmth of the limbs when in bed; indeed, patients with syphilitic tibiæ frequently sleep with their legs exposed. Night-watchmen and others, on the contrary, complain of pain during the day, when they take their rest. Suppuration does not often occur, and constitutional rather than local treatment is required.

In the **Tertiary Period** the bones may participate in the changes which involve any and every tissue of the body. These consist in an overgrowth and infiltration of the connective tissues, which, if diffused through an organ produce sclerosis, if localized to one spot lead to the formation of a gumma. Hence the following lesions are met with:

(*a*) The formation of *subperiosteal gummata*, either localized or diffuse, probably resulting in *caries* of the subjacent bone; if the affection is limited, only a small portion may be thus involved; but where it is widely diffused, an extensive surface of the bone may become eroded and irregular. This process may be accompanied by a development of new bone under the adjacent periosteum, and it is very often complicated by sclerosis and necrosis. The calvarium is the part most frequently involved in this change, and, owing to the osteo-genetic powers of the pericranium being small, there is but little new formation of bone in the neighbourhood, and thus the skull may present a curious worm-eaten appearance (Fig. 175). Frequently the gummata break down and destroy the superficial scalp tissue, leaving deep and extensive wounds, discharging an abundance of foul pus, at the bottom of which bare and even dead bone may be felt.

(*b*) At the same time a condition of *sclerosis* may be produced in the underlying or surrounding parts, and this may progress to such a degree as to seriously compress and constrict the vessels in the Haversian canals. Moreover, an obliterative endarteritis is almost always present, and these factors, combined with the separation of the periosteum by the above-mentioned gummatous changes seriously interfere with the vitality of the bone, so that should sepsis occur from the breaking down of the gummata, necrosis is almost certain to ensue. Caries and necrosis are, therefore, often met with in the same case, and especially in the skull, a central necrosing area being surrounded by a zone of caries (Fig. 176).

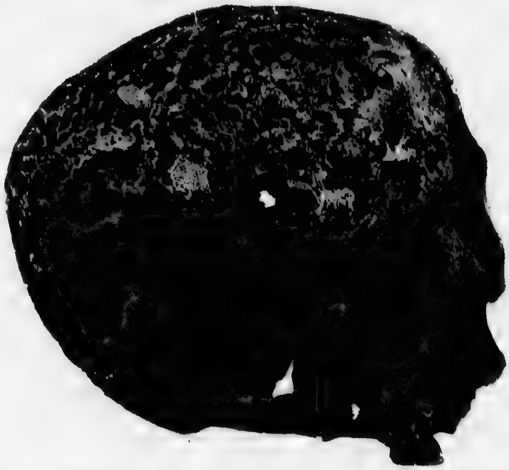


FIG. 175.—DIFFUSE GUMMATOUS DISEASE AND CARIES OF THE SKULL. (FROM KING'S COLLEGE MUSEUM.)

The effects produced vary considerably in different cases, and especially with the situation. When the calvarium is attacked, septic phenomena are commonly present, and necrosis is a usual accompaniment of the gummatous changes. The disease is then marked by its extreme chronicity, the sequestrum lying bare in the wound perhaps for years without being separated, owing to the slight degree of vascularity and the extreme condensation of the surrounding parts. Moreover, as explained above, there is an entire absence of an involucrum. In the shafts of long bones, where the compact tissue is thick and resistant, there may be extensive periosteal disease, with but little affection of the underlying parts; but if this compact layer is thin, and especially when the cancellous ends are involved, a considerable amount of destruction from caries may result, though if sepsis is not admitted there will be an entire absence of necrosis.

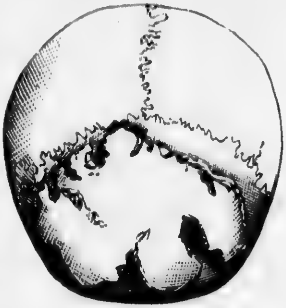


FIG. 176.—SYPHILITIC NECROSIS OF THE SKULL.

The sequestrum is surrounded by a ring of caries.

In the **Treatment** of the two preceding conditions constitutional remedies have to be mainly depended on in the form of iodide of potassium and mercury. Open wounds may be treated by applying iodoform, and dressing with lint steeped in lotio nigra, or covered with mercurial ointment. Necrosed portions, when separated, are to be removed, carious tissue may be scraped away with a sharp spoon, and the surface powdered with iodoform and dressed antiseptically. In the calvarium no attempt must be made to chisel away the dead bone.

(*c*) Occasionally a *gummatous osteo-myelitis* is met with, in which a gumma forms in the interior of a bone. It results in the so-called expansion of bone and secondary thickening and enlargement of its whole structure, *i.e.*, a diffuse osteo-periostitis. The symptoms are the same as those described for the latter affection, and if it resists the administration of anti-syphilitic remedies, it will need to be treated in the same way, viz., by separation of the periosteum, freely opening the medullary cavity, and removing all diseased tissue. These cases when affecting the long bones have often been mistaken for malignant growths; necessarily, it is a matter of the most vital importance to come to a right conclusion as to their nature. The greater rapidity of growth in the syphilitic cases, and the evidences of syphilis elsewhere, or of a syphilitic history, will often guide the surgeon to a right conclusion; but if there is any doubt an exploratory incision should always be undertaken before amputation is resorted to.

In **Inherited Syphilis** any of the above manifestations may be seen, but with more or less special features added, and, in addition to these, certain forms which do not occur in the acquired type of the disease have been described. The following are worthy of being specially noticed:

1. A new formation of bone beneath the periosteum is perhaps the most frequent result, and this occurs with but little pain or evidence of chronic periostitis. Perhaps the most common situation of this lesion in infants is the calvarium, where bony masses known as *Parrot's nodes* may form around the anterior fontanelle, causing the top of the skull to resemble 'a hot cross bun' in shape. In the early stages the bone is soft and spongy, and on post-mortem examination is dark red or maroon in colour. If the process is not checked by suitable anti-syphilitic treatment, the newly formed osseous tissue becomes dense and sclerosed, and the deformity may then persist through life. Any part of the calvarium may, however, be affected, and the change is not necessarily limited to the first years of life.

2. A very similar condition is met with in the shafts of long bones, due to the deposition of alternating layers of soft and hard bone, outside the ordinary compact tissue.

3. *Syphilitic epiphysitis* (or, as it is termed, syphilitic *osteochondritis*) is a condition somewhat simulating rickets, in that the epiphyses become enlarged as a result of the overgrowth of the cartilage. It is met with in young infants, and involves both the epiphyses and the adjacent portions of the shafts, which become expanded and spread out so as to fit into the enlarged epiphyses. The zone of calcified cartilage is friable, opaque, and irregular, and as the condition progresses it may become atrophied, and replaced by granulation tissue, so that separation of the epiphysis may follow. This may in turn result in suppuration, and possibly acute arthritis, or the limb hangs powerless in a condition known as *syphilitic pseudo-paralysis*. The disease is often widely diffused throughout the body, and is found in much the same positions as the true rachitic affections, the lower end of the humerus and the wrist being perhaps most often affected.

The diagnosis from rickets is made by observing the fact that the syphilitic lesion extends further up the shaft, and is not so strictly limited to the articular ends of the bones. Moreover, the concurrent phenomena are not those characteristic of rickets, but are of a syphilitic nature.

4. A symmetrical overgrowth of the tibiæ, perhaps combined with an anterior curvature, also occurs in syphilitic children, resulting in permanent elongation of the legs.

5. *Craniotabes* is also occasionally met with in congenital syphilis. It consists in a localized absorption of the osseous tissue of the cranium, leaving small areas where the bone is thinned or absent, imparting a sensation of parchment to the finger. It is usually seen in the occipital region, and is also found in rickets.

The **Treatment** of syphilitic lesions in children must be carried out in accordance with general principles, and mainly by the administration of suitable drugs.

Rickets.

Rickets is a general disease of malnutrition, occurring in children, and manifesting itself mainly in lesions connected with the bones. It usually commences within the first three years of life, and may be congenital, but sometimes appears later.

Causes.—Any and every fault in the hygienic and dietetic treatment of a child seems capable of inducing rickets; but the most important factors in its ætiology are insufficient or improper food, especially the too early administration of starchy materials; whilst uncleanliness and want of air and light also predispose to it. Prolonged lactation is not necessarily a cause, if the mother is healthy and capable of feeding the child; but amongst poor patients this habit is frequently responsible for its appearance, although in Japan, where the children are suckled for two or three years, the disease is unknown. Rickets is especially common in the poorer classes, who are herded together in small and badly ventilated rooms, and is so peculiarly frequent in this country as to be known in Germany as the 'English disease' (*Englische krankheit*).

The **Symptoms** may be divided into the early or general, and the later or osseous. The *general* symptoms are mainly referable to a state of irritability of the gastro-intestinal mucous membrane. The child may be fat and flabby, or thin and emaciated; the mucous membranes are pale, and vomiting and diarrhœa are constantly present, the motions often being green, slimy, and very offensive. The spleen is enlarged, the abdomen tumid, and profuse sweating of the head is very characteristic.

The commencement of the *osseous changes* is usually indicated by increasing irritability and restlessness, the child tossing off his bed-clothes at night, and crying out when handled or touched. The articular ends of the long bones become enlarged, as also the junction of the costal cartilages with the ribs. Sooner or later the shafts of the long bones soften, and may bend in various directions, and thus a considerable variety of *deformities* may be produced.

The *head* usually becomes flattened antero-posteriorly, so that the forehead appears square in shape and enlarged, whilst frontal bosses may develop on either side, due probably to new formation of bone under the periosteum. Less commonly, if the child lies much on the side of the head, it becomes laterally compressed, the antero-posterior diameter increasing in length. At the same time, the fontanelles remain open much longer than usual, and craniotabes may be observed in the occipital region. The teeth do not appear till late, and are stunted, defective in enamel, and easily eroded, so that the ends of the incisors are often concave; they must not be mistaken for syphilitic teeth, since the concavity is a small arc of a large circle, whilst the typical notch of syphilis is a large segment of a small circle.

The *spine* may be affected by kyphosis (p. 614), or scoliosis (p. 609); the kyphotic curve results when the patient is allowed to lie too much in bed with the head on a high pillow, or if it is carried about with a curved back; scoliosis more often occurs when the patient is able to walk about. Occasionally the two conditions are associated in the same child, a kypho-scoliosis resulting, which is usually due to its being carried about on the nurse's arm with its spine curved.

Changes in the *thorax* are produced by enlargement of the costo-chondral junctions (*beaded ribs*), which, when present on either side of the sternum, produce what is known as the *rickety rosary*. If there is any obstruction to the entrance of air into the lungs, as from a tracheitis or bronchitis, the atmospheric pressure may cause the softened bone and cartilage to sink inwards, and as a result of this the sternum may be pushed forwards (*pigeon breast*), whilst the curvature of the ribs at the angle is increased. A very characteristic feature of the rickety change consists in the lateral groove thus produced on each side of the sternum, which may meet with a transverse depression below, caused by the pressing outwards of the lower ribs by the tumid abdomen.

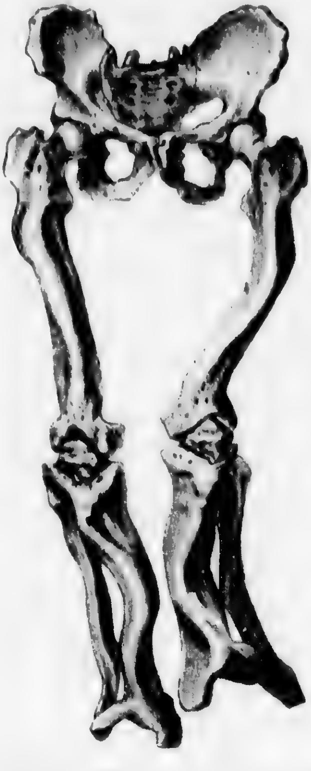


FIG. 177.—PELVIS AND LEG-BONES IN RICKETS. (FROM COLLEGE OF SURGEONS' MUSEUM.)

The *pelvis* may be flattened antero-posteriorly, or it may be tri-radiate, the former condition being produced when the patient lies habitually on his back, the latter only occurring when he is allowed to walk about, the acetabula being thus pressed inwards and backwards by the heads of the femora.

The deformity of the *long bones* (Fig. 177) usually consists in an increase in their natural curves, these being especially marked at points where powerful muscles are attached. The femora are curved antero-posteriorly, and the tibiæ in a similar direction, although there is often some lateral displacement superadded. Genu valgum or varum may also result from the epiphyseal changes.

When the acute stage of rickets has passed away, any deformities present become fixed by the complete ossification of the softened bony tissues. As a rule, the density of such deformed bones is much increased, whilst their natural shape is considerably altered by deposits of new subperiosteal bone or struts in the concavities, so that on section they are usually more or less flattened from side to side. Growth, too, is often much impaired by this disease, so that the individual may become stunted and dwarf-like.

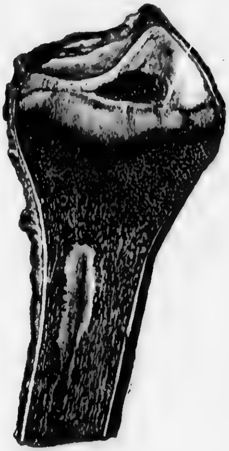


Fig. 178.—Section through Lower End of Rickety Radius, showing Exaggerated Depth and Irregular Borders of the Proliferating Epiphyseal Cartilage.

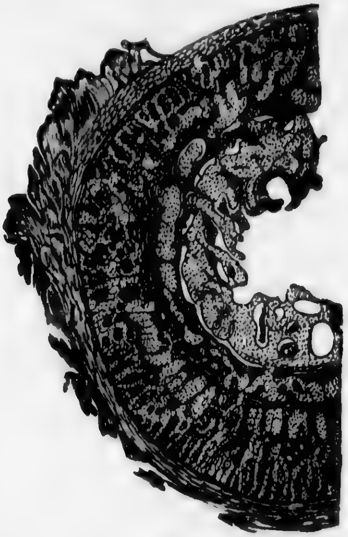


Fig. 179.—Transverse Section through the Shaft of the Ulna from a Rickety Child of Thirteen Months (× 10), showing Spongy Tissue beneath the Periosteum instead of the Compact Tissue of Normal Bone.

(From Ashby and Wright's 'Diseases of Children.')

Pathologically, the chief changes in rickets are found in the neighbourhood of the epiphyses. Ordinarily, the epiphyseal cartilage is a regular lamella about a line in thickness, bounded on either side by a zone of calcified tissue, containing regular alveolar spaces filled with vascular medulla, and lined by osteoblasts, shelving gradually into normal cancellous bone. In rickets the epiphyseal cartilage is not only circumferentially enlarged, but also thickened and irregular (Fig. 178), outgrowths of cartilage projecting on either side into the calcified tissue, which is increased in amount and more open in texture than usual, whilst it passes irregularly into the cancellous bone. Thus, there is an increase in the material which Nature prepares for the formation of bone, but the ossifying process is inefficiently carried out. In addition to this, the Haversian canal systems and the medullary spaces in the diaphyses of the bones are increased in size, so that they become abnormally porous from the insufficient amount of lime salts present, and thus readily bend under the weight of the body or from muscular action. Somewhat less frequently the subperiosteal compact bone becomes similarly rarefied (Fig. 179), and a new formation of soft vascular tissue may form beneath it, which later on becomes condensed, thus increasing the thickness and sectional area of the bone.

In the **Treatment** of rickets the most essential feature in the early stages is the correction of all errors in the personal hygiene. The diet should consist of good cow's milk, diluted if need be, and with lime-water added; whilst the juice expressed from raw beef, or one of the many meat juices now sold, may also be administered. The condition of the bowels must be attended to, and the child placed in as good sanitary surroundings as possible. Parrish's food (syr. ferri phos. co.) may be given alone, but if the infant is thin and emaciated, cod-liver-oil should be added. Deformities must be prevented, if possible, by keeping the child in the recumbent posture, and not allowing it to crawl or run about. The early stages of deformity may often be corrected by daily manipulation of the affected bones, and in the later stages they may be improved by suitable apparatus for immobilizing the limb, combined with pressure. Osteotomy, or even resection of portions of bone, is called for in the severer cases (see p. 626).

Scurvy Rickets (*syn.* : **Acute Rickets, Hæmorrhagic Rickets**).—Considerable attention has been directed of recent years, notably by Dr. Barlow, to a curious condition met with in children, which seems to combine some of the most marked features of rickets and scurvy, but in which either one or the other set of phenomena may predominate. It is usually seen in the children of well-to-do people, and apparently arises from defective nutrition, especially from the prolonged administration of peptonized or prepared foods, together with an absence of fresh meat and vegetables. In the slighter cases there may be but little evidence of the scorbutic condition, beyond the fact that in a rickety child there is some tendency for the gums to bleed, or a little hæmaturia; but in those that are more marked the rickety signs are of little importance compared with those due to hæmorrhagic extravasations. The disease often comes on suddenly with some amount of pyrexia, rarely exceeding 102° F., but the child is evidently ill, and perhaps complains of tenderness of the limbs, which may be kept so quiet as to suggest that they are paralyzed. This is followed by the appearance of swellings of some size, due to subperiosteal extravasations, the skin over the affected parts being at first shiny and œdematous, but subsequently becoming stained by the blood pigment. The femur and tibia are most often affected in this way, and the epiphyses may occasionally become detached, or even spontaneous fractures occur. Bleeding may also take place beneath the conjunctiva or into the orbit, leading to protrusion of the eyeball, whilst there may be blood-stained diarrhœa, hæmaturia, or epistaxis.

The disease, when recognised, is readily amenable to *treatment*, but should its nature be overlooked, the child is likely to become emaciated and die. Attention to the diet is the main point to be attended to, for when fresh milk, lime-juice, or vegetables are given, the symptoms soon disappear. The affected limbs must be kept at rest, and cooling lotions applied, whilst splints are employed for separated epiphyses or fractures.

Mollities Ossium (*syn.:* **Osteo-malacia**).

This disease is one of somewhat unusual occurrence, characterized by the absorption of the mineral osseous substance, as a result of which softening and rarefaction are produced, giving rise to bending of the bones or spontaneous fracture.

The complaint is almost limited to the female sex, and usually commences during pregnancy; it is stated to be sometimes connected with a rheumatic tendency. Any part of the skeleton may be affected, but most frequently the pelvis, spinal column and ribs; the bones of the limbs are occasionally involved.

Pathologically, the change consists in a replacement of the medullary substance by a soft fibro-cellular tissue, which is exceedingly vascular, and into which hæmorrhage often occurs owing to the loss of the support to the vessels. The material resulting looks in the fresh state something like splenic pulp. The bony cancelli are absorbed, as also the greater part of the compact tissue, with the exception of a thin layer situated beneath the periosteum. Part of the bone substance remains for a time in a decalcified state, with the corpuscles evident, but all the lime salts have disappeared, escaping as phosphates in the urine and fæces. Probably some acid, *e.g.*, lactic acid, is the active agent in dissolving the earthy salts, but as to this little is known. It has also been suggested that the process is due to excessive absorptions of some internal secretion, particularly that from the ovary, an idea developed from the fact that removal of the uterine appendages has in a few cases stayed the disease.

Clinically, the onset is usually exceedingly obscure, the only complaint being that of pain of a rheumatic nature in various parts of the body, whilst the patient becomes emaciated and exhausted. Sooner or later skeletal changes manifest themselves and demonstrate the character of the disease. The limbs may either bend or break; in the latter case there is no attempt at repair. The pelvis becomes tri-radiate in shape owing to the acetabula being pressed inwards and backwards by the weight of the body and in pregnant women this may cause so much deformity as to call for Cæsarian section or Porro's operation. Death may result from exhaustion, or from obstruction to parturition, or the patient may live more or less bedridden for some years.

As to **Treatment**, nothing very satisfactory can be accomplished. Opiates may be administered to relieve pain, and various drugs, such as alum, and phosphate or hypophosphite of lime, have been recommended. In cases not associated with parturition or pregnancy, the operation of oöphorectomy has been stated to have been employed with benefit. The induction of premature labour is considered by some to be beneficial, not only for the sake of obviating the necessity for such operations as Cæsarian section, but also on the chance of checking the progress of the disease.

Osteitis Deformans.

Osteitis deformans is an inflammatory disease of the osseous skeleton, first described by Sir James Paget in 1876. The onset is insidious, and the progress very slow. It is characterized by a painful overgrowth of the long bones, spine, cranium, and pelvis, which are also softened, so that those which bear the weight of the body become curved. It may commence in one bone alone, and then usually the tibia or femur, but more often many bones are affected at the same time. Attention may be drawn to the condition, either by the pain, which the patient usually considers at first to be rheumatic, or by the general enlargement and bending of the bones, or by the increased size of the head, necessitating the use of larger hats. The cranial overgrowth is eccentric in character, and the vault of the skull may become very thick; the facial skeleton, however, is not much affected. The spine becomes markedly kyphotic (Fig. 180), the dorsal curve being increased, and the lumbar concavity obliterated; it is nearly rigid from ankylosis of the vertebræ, and may be very painful. The head is carried forwards by the bend of the spine, the height is diminished, the shoulders are round, and the chest sunken towards the pelvis; the gait also is slow and awkward. The disease usually attacks middle-aged men; its progress is exceedingly slow, the patients often living to an advanced age, or dying from some intercurrent malady. Some cases have terminated in multiple sarcomata of the bones. The structure of the osseous tissue is suggestive of inflammatory rather than degenerative changes. It is softer and more uniform in structure than usual, the difference between the cancellous and compact tissue being less defined; the Haversian canals are large, and arranged irregularly, whilst the bony substance itself is chalky-looking.

Differential Diagnosis.—From *arthritis deformans*, which it resembles by the attitude and gait of the patient, it is known by the absence of articular lesions, especially in the fingers, and the enlargement of the bones, notably of the cranium. From *acromegaly* it is distinguished by the absence of enlargement the hands, feet, and lower jaw.

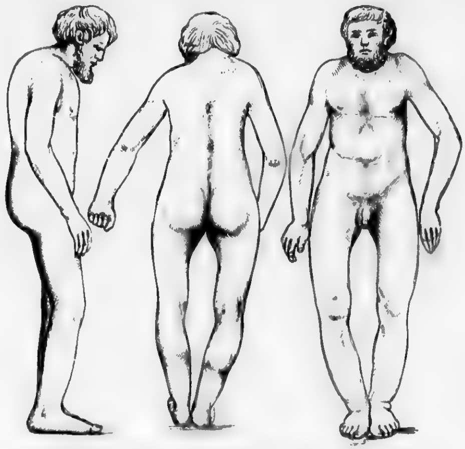


Fig. 180.—Osteitis Deformans. (Bryant.)

Treatment is most unsatisfactory, no remedy at present known having apparently any control over the disease.

Acromegaly.

Acromegaly is a rare condition the characteristics of which have only recently been described (by Dr. Pierre Marie in 1885). It is a general affection involving mainly the osseous system, commencing usually in young adults, and finally, after lasting for a long time, destroying the patient by syncope or cerebral compression, if some intercurrent malady does not destroy him.

It is characterized by a very definite enlargement of the hands and feet, which are, however, not lengthened, so that the hands have been compared to battledores, and the fingers to sausages. The bones themselves are enlarged, and the soft structures on the palmar aspects project as pads. The nails and skin are unchanged, whilst the other segments, both of the upper and lower limbs, are unaffected. As to the skull, both the upper and lower jaws are thickened and prominent, whilst the lower lip is enlarged and overhanging. The orbital ridges project, and the forehead is usually low; both the nose and tip of the tongue are more or less enlarged. The face thus takes the shape of an elongated oval. The spine is markedly kyphotic in the dorsal region, with a slight lumbar lordosis. The ribs and sternum project anteriorly.

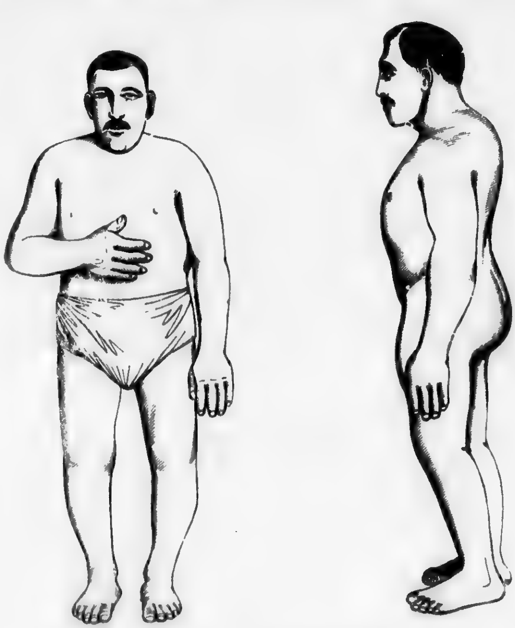


FIG. 181.—ACROMEGALY.

The patient usually suffers from headache, lassitude, and great fatigue, wandering pains about the body, and excessive appetite and thirst; amenorrhœa is a marked symptom in women, whilst men suffer from a loss of virile power. The urine is abundant, but of a low specific gravity. Vision is usually diminished, and optic neuritis has been observed in some cases.

Morbid Anatomy.—But little is known as to the cause or pathological changes occurring in this disease, beyond the fact that the anterior glandular half of the pituitary body is hypertrophied, and the sella turcica expanded. The changes in the bones are merely those of overgrowth.

Diagnosis.—The disease has been mistaken for *myxœdema*, but there is not much difficulty in distinguishing the two if it be remembered that, in the latter condition, the skin is not mobile over the thickened subcutaneous tissue, that the face is broad, pasty, and puffy, and that masses of gelatinous tissue are found above the clavicle, whilst in acromegaly the face is elongated, and the skin and subcutaneous tissues normal. The mental condition and speech of a patient suffering from myxœdema are widely different from those in acromegaly; whilst in the former the thyroid body is absent, and in the latter skeletal changes are present. From *chronic osteo-arthritis* affecting the hands, the diagnosis is easy, in that there are usually no signs of articular disease, and much less pain. From simple *gigantism*, acromegaly is distinguished by the absence of any increase in length of the fingers and toes. From *osteitis deformans*, the distinguishing features have already been indicated.

Treatment is merely symptomatic, antipyrine being useful in relieving the headache, as also valerianate of caffeine.

Another curious affection which has been recently described is that known by the somewhat formidable title of **Hypertrophic Pulmonary Osteo-arthropathy**. It has been long known that clubbing of the terminal phalanges was a common accompaniment of chronic pulmonary disease; but this new affection is a good deal more extensive. The terminal phalanges of the fingers and toes are enlarged and bulbous, with the nails curved over them towards the palm or sole; there is also a considerable swelling of the bones just above the wrists and ankles, and possibly a similar condition around other joints. The spine is kyphotic in the upper dorsal region, but with a well-marked lordosis below. It is thus seen that the changes are somewhat like those of acromegaly, from which, however, it is distinguished by (*a*) the implication only of the terminal phalanges; (*b*) the swellings above the wrists and ankles; and (*c*) the absence of the characteristic deformities in the skull and head. The explanation of these phenomena is that probably they are due to a chronic osteitis, due to toxic absorption, since the condition arises in such diseases as chronic bronchitis, bronchiectasis, and chronic empyema, where suppuration has existed for some time. Little can be done in the way of treatment, except to remove the cause.

Tumours of Bone.

Many different varieties of tumours growing from bone are met with. The characters of the osteomata, chondromata, and fibromata have been described in Chapter VI. Hydatid cysts, and various solid and cystic tumours connected with the teeth, are also dealt with elsewhere.

Sarcoma is the most important primary tumour of bones, and almost any form may be seen. The microscopical characters have been detailed in the chapter on tumours, and we shall therefore only refer here to their *clinical characteristics*. They may be divided into two main groups—the endosteal or central, and the periosteal.

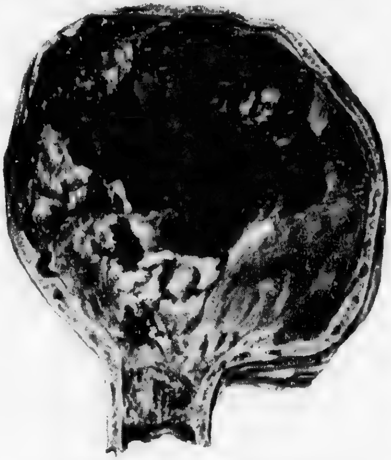


FIG. 182.—ENDOSTEAL SARCOMA.

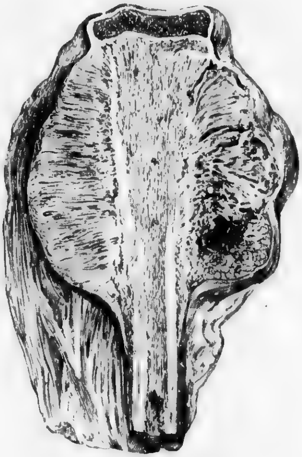


FIG. 183.—PERIOSTEAL SARCOMA. (BRYANT.)

Endosteal or Central Sarcoma (Fig. 182) of bone commences in the medullary cavity, and results in the so-called 'expansion of bone,' which consists more correctly in absorption of the bony tissue from within, whilst at the same time new bony tissue is being deposited from the under side of the periosteum, though in these cases only to a limited degree. The **Symptoms** at first resemble those of chronic osteo-periostitis, although in most cases of tumour there is rather less pain. The growth usually commences near the end of a long bone; it seldom encroaches on the articular cartilage, so that the joint, as a rule, escapes, although it may contain an excess of serous fluid; occasionally, however, the growth may extend laterally beyond the level of the cartilage, and thus encroach on the articular cavity. Spontaneous fracture is not an uncommon complication of this condition, and owing to the excessive expansion of the bony framework 'eggshell crackling' is sometimes met with. After a while, the growth may extend beyond the osseous limits into the soft parts, and then the chances of general dissemination are considerably increased. The chief **varieties** of sarcoma met with growing from the interior of long bones are the round- or spindle-celled, and the myeloid. The two former tend to diffuse themselves widely throughout the medullary cavity, and to infect the neighbouring tissues and the system generally. Not unfrequently cartilaginous nodules may be found scattered through the mass. *Myeloid* tumours are much less malignant in character, never giving rise to secondary deposits, either in lymphatic glands or viscera, and their growth within the bone being distinctly limited to the region from which they originated; sometimes a layer of condensed bone forms a definite barrier to check its advance. The sites of election for myeloid tumours are the lower ends of the femur and radius, and the upper ends of the tibia and humerus—that is, at the sites where the growth of the limbs is greatest; they also grow within the horizontal ramus of the lower jaw and the diploe. Not uncommonly a fibro-sarcomatous epulis is myeloid in nature.

In considering the nature of an endosteal sarcoma, it should be remembered that myeloid tumours grow more slowly than the round- or spindle-celled, and are more likely to develop cysts owing to hæmorrhage into their substance. In all of them a certain amount of bony skeleton may pervade the growth.

The **Periosteal Sarcomata** (Fig. 183) are round- or spindle-celled in nature. They often grow very rapidly, without giving rise to much pain, unless causing erosion of the bone. They usually start on one side of the bone, but later on may surround its whole circumference. They spread rapidly along its exterior, and are highly malignant in nature, giving rise to secondary growths in the neighbouring lymphatic glands or in the viscera. They frequently become ossified, with or without the development of cartilage, and in such cases the subjacent bone becomes sclerosed and thick. The bony skeleton of such a growth is very characteristic, consisting of fine spiculated trabeculæ, radiating more or less regularly from the surface, and looking in the dried state something like asbestos. When a periosteal sarcoma does not become ossified, the growth usually erodes the underlying bone, and may lead to spontaneous fracture; the tumour in such cases will be softer and more elastic than in the former variety. All osseous sarcomata are exceedingly vascular, and may even pulsate, and the superficial veins are obviously dilated beneath the stretched integument, giving rise to a blue network.

The **Diagnosis** of osteo-sarcoma in the early stages is often a matter of the greatest difficulty. The endosteal form may easily be mistaken for chronic osteo-periostitis, medullary gumma, or a deep abscess of the bone, and can sometimes only be distinguished from them by an exploratory incision, which should always be undertaken in doubtful cases prior to radical operations, such as amputation. In the later stages, the presence of 'eggshell crackling' or cystic change will help to make evident the nature of the disease. The periosteal form may at first be looked upon as a periosteal node, or a deeply placed abscess. The rounded and definite edge of the growth, its irregular consistency, and the history of the case, will assist in the determination of its nature; but in the early stages an exploratory operation is not unfrequently called for. For the diagnosis of a pulsating sarcoma from an aneurism, see p. 251. When either form involves the articular end of a bone, it may simulate tubercular disease; especially is this the case when the lower end of the femur is involved. It will, however, be noted that the centre of the swelling corresponds to a point well above the joint, that a certain amount of movement is possible, and even without pain, whilst the starting pains at night characteristic of joint mischief are absent. The age of the patient, and the presence or not of cachexy, are also important features which have to be taken into consideration. Skiagraphy may serve in some cases as an important diagnostic adjuvant (Fig. 184).

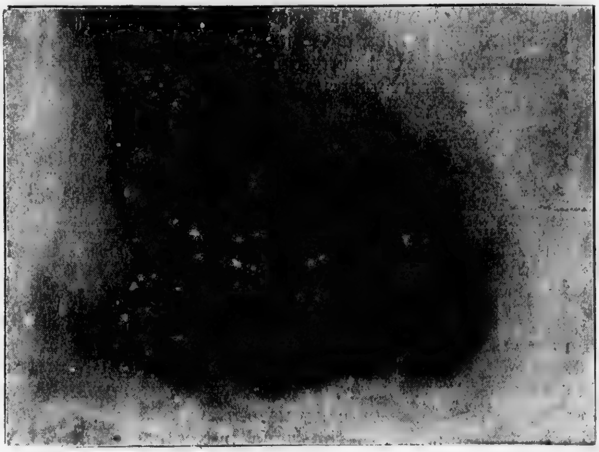


FIG. 184.—SKIAGRAM OF SARCOMA OF OS CALCIS.

The outline of the growth is only imperfectly defined, owing to the limiting portion of the tumour being soft and fleshy, and containing no osseous deposit.

The **Treatment** of osteo-sarcoma must always be of a radical nature, and, remembering the malignant character of many of these growths, we would strongly urge on surgeons the importance of an early exploratory operation in doubtful cases; if undertaken with antiseptic precautions no harm can ensue, and a definite diagnosis is thereby possible. If the case is left until increased growth reveals the true state of affairs, it is more than likely that, except in myeloid sarcomata, it will be too late for successful operative interference. When once a diagnosis has been established, amputation should, where practicable, be performed without delay. In every form of the disease except the myeloid, the limb should be removed high above the tumour. Thus, if growing from the lower end of the tibia, disarticulation at the knee-joint should be performed; if at the upper end of the tibia, amputation through the middle or lower third of the thigh; if from the lower end of the femur, amputation through the upper third of the bone, if not at the hip-joint. When the soft parts or muscular bellies are also invaded, it is desirable to include the whole of them in the scope of the operation.

Myeloid sarcomata being practically non-malignant, except locally, are dealt with in a much more conservative manner, amputation through healthy tissue just above the growth being all that is called for. It is advisable that the medulla at the point of section of the bone should be examined microscopically before the wound is closed, to make certain that it has not been invaded. When affecting the lower end of the radius, an attempt may be made to save the limb by excising the diseased portion of bone; if a portion of the ulna is also taken away at the same time, there is less chance of the hand being drawn up and abducted towards the radial side, and hence it is likely to become more useful. Central sarcoma of the lower jaw, if myeloid in nature, may be treated by making a free opening in the bone, scraping the diseased tissue away, and swabbing out the cavity with pure carbolic acid. The continuity of the jaw may thus be maintained, even if the teeth are lost. Several successful cases treated according to this plan have been recently recorded.

Secondary Sarcoma of bone is by no means uncommon. It is usually endosteal in character, and, except in the most unusual circumstances, will not demand treatment, owing to the general infection of the system. Possibly where it has led to spontaneous fracture, and there is much pain owing to the difficulty of fixation, it would be justifiable to remove the limb.

Carcinoma of bone is always secondary in nature, although it may be involved by direct extension in a primary growth. It may occasionally lead to spontaneous fracture.

A rare form of secondary carcinoma of bone is that known as **Thyroid Cancer**. The primary growth is in the thyroid body, whilst the secondary deposits in the bone are exactly similar in structure to it, and usually pulsate strongly.

Pulsating Tumours of Bone, or Osteo-aneurism.—Not a few cases of sarcoma of bone, whether central or peripheral in character, have an evident pulsation, owing to their extreme vascularity, the thin-walled vessels in their substance being even dilated and aneurismal. Apart from these, two distinct classes are met with, the nature of which cannot be considered as yet settled, in which distinct pulsation is also noticeable.

In the first of these the medullary cavity is occupied by a non-malignant vascular tissue, practically identical with what we have already described as an *aneurism by anastomosis*. A large number of small arterioles open into spaces without the intervention of capillaries, so that an erectile tissue similar in nature to the corpus cavernosum penis results. Such tumours are situated most frequently in the cranial bones, and may be multiple, the medullary tissue being in consequence atrophied, and the compact tissue thinned, so that eggshell crackling may be obtained.

The second form is found most commonly in the upper end of the tibia, or some such cancellous mass. It consists of a hollow cavity formed in the cancellated tissue, and filled with blood. Several distinct arterial twigs may open into it, and the overlying bone is thinned and absorbed. It is probable that the majority of such cases are in reality due to the breaking down of sarcomata of extreme tenuity.

The **Diagnosis** of these conditions from an ordinary aneurism is alluded to elsewhere (p. 251); but it is often impossible to distinguish one form of pulsating tumour of bone from another without an exploratory incision.

The **Treatment** of these cases must necessarily vary with the condition found after the preliminary incision into the substance, which should always be made after rendering the limb bloodless. Where it seems probable that the condition is not associated with malignant disease, or is merely due to a myeloid tumour, the cavity should be well scraped, swabbed out with pure carbolic acid, and then tightly stuffed with gauze, so as to obtain healing by granulation from the bottom. In other cases amputation is the only treatment.

Hydatid Disease of Bone.—The cancellous tissue of bones occasionally becomes the site of hydatid development, any part either of the medullary cavity or of the ends being involved. As a result the bone becomes expanded, with all the symptoms of an endosteal growth. Considerable deformity may occur, and when the compact layer has become sufficiently absorbed, spontaneous fracture may follow. One great characteristic of this affection is that there is no limiting cyst wall, the small daughter cysts being diffused widely throughout the affected area. A diagnosis is little likely to be made (at any rate, in this country, where hydatid disease is so rare) prior to an exploratory incision. **Treatment** must necessarily vary with the extent of the mischief. If all the cysts can be removed without interfering with the integrity of the shaft, a recovery, with good subsequent utility of the limb, should follow. Where, however, the disease has encroached widely on the bony tissue, whether spontaneous fracture has occurred or not, amputation holds out the only prospect of cure.

CHAPTER XIX.

DISEASES OF JOINTS.

Synovitis.

By **Synovitis** is meant an inflammation limited almost entirely to the synovial membrane, the ligaments and other structures of the joint being usually but little affected.

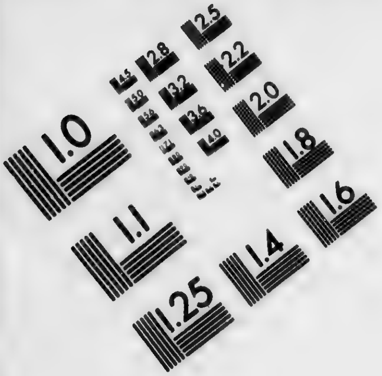
The **Causes** of synovitis are local and general. Local conditions include cold and injury; general or constitutional comprise rheumatism, gout, syphilis, pyæmia, and gonorrhœa. The manifestations may be acute, subacute, or chronic.

Acute Synovitis.

Pathological Anatomy.—Acute synovitis results in hyperæmia of the synovial membrane, and exudation of plasma and leucocytes, firstly into the substance of the membrane, causing it to be thickened and spongy, and subsequently into the joint; the endothelium also proliferates, and is shed. In the early stages the effusion consists of synovia, diluted with blood plasma, and hence on removal is spontaneously coagulable; but after a time the plasma may either be absorbed or coagulate, depositing lymph upon the articular surface whilst serum remains. The lymph thus deposited may either be removed by a natural process of absorption when the inflammation comes to an end, or it may organize, so as to form adhesions. In the later stages the synovial membrane is left somewhat thickened, and the ligaments possibly a little infiltrated and relaxed; a varying amount of passive effusion into the joint cavity is associated with it.

The **Clinical Signs** of acute synovitis consist in the joint becoming painful and distended, whilst if the articulation is superficial, as in the knee, a sense of heat may be imparted to the hand, and the surface may even be red and hyperæmic. The limb is maintained by muscular spasm in that position which gives the most ease, viz., that in which its capacity is the greatest, and this is usually one of slight flexion. The muscles governing the movements of the joint have occasionally been noticed to undergo rapid atrophy, probably resulting from a reflex disturbance of their trophic centres in the cord.

Evidence of Effusion into Various Joints.—*Shoulder:* The curvature of the shoulder is increased, and the deltoid expanded by a fluid swelling beneath it, which is especially noticeable at its anterior border along the bicipital groove, and sometimes posteriorly; in the axilla a painful intumescence may also be felt. These symptoms may be somewhat simulated by inflammation of the multilocular subdeltoid bursa, but the latter condition is recognised by the absence of any axillary swelling, by its not encroaching on the anterior and posterior borders of the deltoid, and by the fact that, although when the patient voluntarily moves his arm pain is produced, yet when the surgeon gently manipulates it, so as to press the head of the bone against the glenoid cavity, there may be none. *Elbow:* The hollows on either side of the olecranon and tendon of the triceps are replaced by soft fluid swellings, the outer of which also extends down to, and masks, the head of the radius; there is usually a little general puffiness in front of the joint. It is readily distinguished from inflammation of the olecranon bursa by the fact that in the latter condition there is a central fluid prominence over the bone, whilst in the former the swellings are placed on either side of and above the bony projection. *Wrist:* There is a general fulness both on the anterior and posterior aspects of the joint, whilst fluctuation may be detected beneath the dorsal tendons, which are slightly separated and displaced. It is distinguished from synovitis of the superjacent tendon sheaths by the fact of its strict limitation to the neighbourhood of the joint, and the absence of the superficial crepitus, so characteristic of the latter condition. Effusion into the *Hip-joint* cannot be easily detected by digital examination. There may be a little fulness and tenderness in the gluteal region, or in the upper and outer part of Scarpa's triangle. The most characteristic feature, however, is the position of flexion, abduction, and eversion taken by the limb, whilst limitation of movement is equally marked. The *Knee*, when distended with fluid, presents a rounded outline, in which all the normal hollows, especially those on either side of the patella and ligamentum patellæ, have disappeared. There is also a swelling corresponding to the subcrureal pouch, more marked on the inner than the outer side, and extending for 3 or 4 inches above the patella. Fluctuation can be readily detected when one hand is placed on the suprapatellar pouch above, and the fingers of the other hand compress the tissues on either side of the ligamentum patellæ below, or by alternate pressure on either side of the rectus tendon. When the effusion is large in amount, the patella can be felt to float, and on pressing it sharply backwards can be made to tap against the intercondyloid notch of the femur. Enlargement of the bursa patellæ is easily distinguished from it by the swelling



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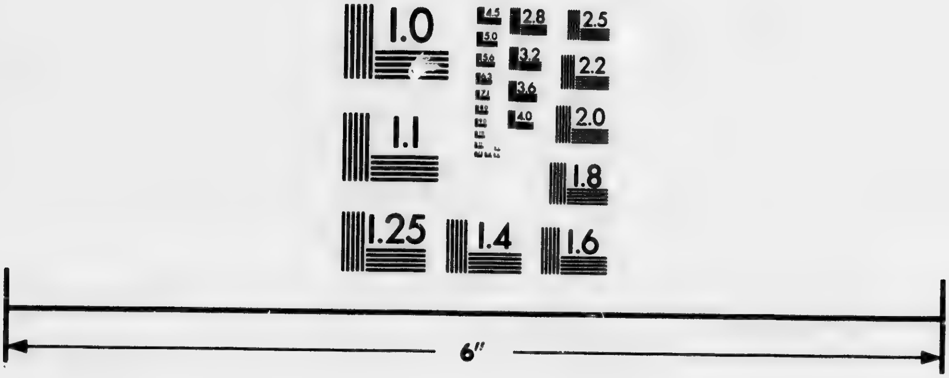

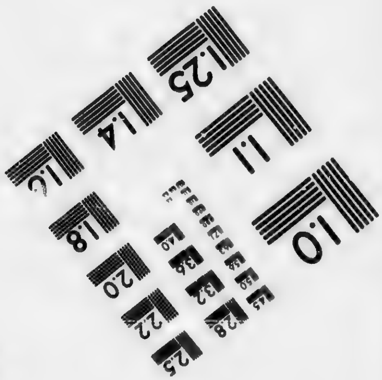

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in the former case being central and in front of the patella, so that its outline is obscured. *Ankle:* The hollows between the tendo Achillis and the malleoli are replaced by fluctuating swellings, whilst the dorsal tendons are displaced forwards. Enlargement of the bursa beneath the tendo Achillis is so obviously confined to the back of the joint that it should never be mistaken for true synovitis of the ankle.

When the acute stage has passed, the joint is usually left in a somewhat weak and relaxed condition, with a little passive effusion, or perhaps some adhesions. The *adhesions* which follow acute synovitis are usually slight in character; they result from the union of patches of lymph on opposing surfaces of synovial membrane or bone, which become organized into loose fibro-cicatricial tissue containing a few delicate bloodvessels, and covered by endothelium extending over them from the adjacent serous membrane. The characteristic signs of such a condition are painful limitation of movement in some particular direction, and possibly a little soft crepitus.

The **Treatment** of acute synovitis of simple origin consists in so immobilizing the joint as to give the patient the greatest amount of ease, whilst, should ankylosis result, the limb is left in as favourable a position as possible for subsequent utility. Thus, the *shoulder* should be bandaged to the side and the hand kept in a sling; the *elbow* is placed on an internal angular splint, and flexed to a little more than a right angle, whilst the hand is midway between pronation and supination; for the *wrist* all that is needed is to apply a palmar splint to the forearm; the *hip* is immobilized by the application either of a Thomas's splint or of a Liston's long splint, or by placing the limb between sandbags and adjusting an extension apparatus to the foot; the *knee* is put on a back-splint, perhaps slightly flexed; whilst the *ankle* is best kept at rest by applying what is known as a Roughton's splint, *i.e.*, an external splint with a foot-piece. Necessarily, in all severe cases of acute synovitis the patient should be confined to bed and the limb elevated. If the case has been neglected and the limb has assumed a vicious position, the patient should be anæsthetized and the malposition corrected; or gradual extension made by means of a weight and pulley, until the correct position is attained. In the early stages cold should be applied to the joint, as by means of evaporating lotion; an icebag or Leiter's tubes may be used, but this is not advisable in old people. In the later stages hot fomentations give greater relief, whilst the application of a few leeches may also be beneficial. When the distension is considerable, removal of some of the fluid by a carefully purified aspirator, or trocar and cannula, may diminish pain and hasten recovery.

In the subacute stage, when the joint is weak and relaxed, massage or friction with stimulating liniments should be employed, whilst in the more chronic forms firm pressure, and preferably by means of a Martin's bandage, is most useful as an additional measure.

If adhesions are present, they should be carefully broken down under chloroform; the limb is subsequently kept at rest for a few days upon a splint, whilst passive movements and massage are afterwards adopted.

Special Forms of Synovitis.

Rheumatic Synovitis is met with in the course of acute rheumatism, or it may exist as a chronic affection from the commencement. The former is recognised by the presence of fever, acid sweats, high-coloured urine loaded with lithates, and a tendency to metastasis, one joint after another being involved; as a rule, complete resolution follows, but there may be some thickening of ligaments and consequent impairment of mobility. If the disease is limited to one joint, absolute disorganization, though without suppuration, may ensue (acute rheumatic arthritis). The chronic variety has no very characteristic features if it remains as a synovitis; but occasionally it involves other elements in the joint, constituting a true chronic rheumatic arthritis, which is often mistaken for osteo-arthritis (p. 579).

The **Treatment** of the acute form is rather constitutional than local, and consists in the administration of large doses of salicylate of soda; at first, when the temperature is considerably raised, 20 grain doses are given every three or four hours, but as the pyrexial phenomena disappear, these are gradually diminished in frequency and amount, until merely 10 grain doses are given thrice daily. Some patients cannot take salicylates, as they induce maniacal attacks of alarming severity; under these circumstances the practitioner must depend on quinine and bicarbonate of potash. Locally, the joints should be wrapped up in warm cotton-wool, or, perhaps better, hot soda fomentations may be applied. In the more chronic forms salicine and iodide of potash are perhaps more effectual, together with alkaline mineral waters, whilst stimulating friction and massage may also be adopted.

Gouty Synovitis is characterized by certain well-marked features. As a rule, it attacks the metatarso-phalangeal articulation of the great toe (podagra), or the metacarpo-phalangeal joint of the thumb (cheiragra). Its onset is often sudden, and it frequently commences in the middle of the night. The joint becomes swollen, red, shiny, and œdematous, whilst the superficial veins are prominent. The attack is exceedingly painful, and the skin exquisitely tender. These symptoms pass off in the course of a few days, leaving the articulation swollen and sensitive.

Pathologically, even a single attack results in a slight deposit of urate of soda in acicular crystals in the matrix of the articular cartilage close to the surface; but when the joint has been several times inflamed the whole thickness of the cartilage may be invaded by this chalky deposit, whilst the ligaments and ends of the bones are also infiltrated. In the smaller joints it may increase to such an extent as to form well-marked swellings, or 'tophi,' similar in character to those so commonly seen in the external ear. The skin sometimes gives way over these, and a chalky discharge results. Fig. 185 is a skiagram of a gouty hand, which gives an idea of the osseous lesions associated with this disease. In some cases erosion of the cartilages is met with, and eburnation of the exposed bone may follow, as in osteo-arthritis. The *treatment* of acute gout consists in fomenting the parts with hot water, or applying glycerine of belladonna, whilst colchicum, citrate of lithia, and alkaline purgatives, are administered. In the more chronic forms iodide of potassium, and possibly piperazine, may be given, whilst the diet and drink are carefully regulated.

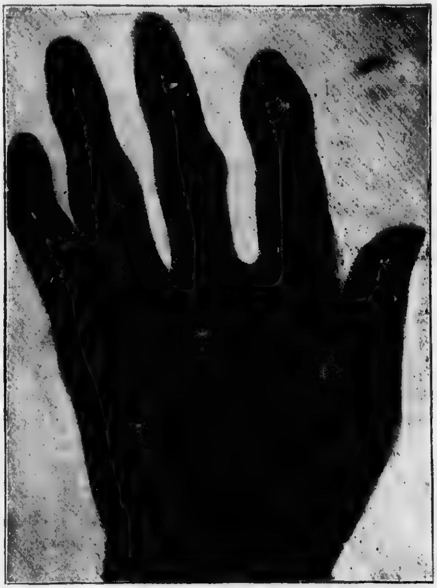

FIG. 185.—SKIAGRAM OF GOUTY HAND.

Much of the detail has been lost in reducing the size, but several deposits of urate of soda can be clearly distinguished, as well as the partial dislocation of one of the terminal phalanges.

Gonorrhœal Synovitis rarely arises before the third week of the complaint, when the discharge is becoming subacute. It usually attacks several joints, the knee, wrist, and ankle being those most commonly involved, and that not unfrequently on both sides of the body. It is marked by considerable effusion around the joint, whilst that within is often but slight. The affection is very painful and extremely chronic. If it is limited to one joint, disorganization may result, with or without suppuration (gonorrhœal arthritis), and ankylosis is an occasional consequence even of the synovial form. The affection is due to the development in the synovial membrane of the gonococcus, carried from the urethra by the blood-stream; but if suppuration ensues, probably pyogenic organisms are also present. The *treatment* is most unsatisfactory. The urethral discharge must not be checked too suddenly, though its gradual disappearance is desirable, whilst complete rest to the affected joints, moderate pressure and counter-irritation, *e.g.*, by the use of Scott's dressing, should be employed. Perhaps iodide of potassium, mercury, and quinine are the best drugs to administer.

Pyæmic Synovitis is due to embolic infection from some suppurating focus. The joint becomes rapidly distended with pus, and often without pain. If it is promptly evacuated and the joint washed out and drained, its disorganization may be in many cases prevented (*vide* pyæmia, p. 107); otherwise destructive changes will quickly follow.

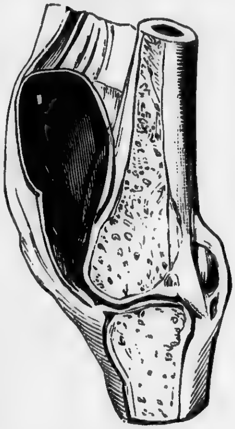

FIG. 186.—CHRONIC SEROUS SYNOVITIS OF KNEE, WITH DISTENSION OF THE SUBCRUREAL POUCH. (FROM COLLEGE OF SURGEONS' MUSEUM.)

CHRONIC SYNOVITIS.

This affection follows an acute attack, or may be lighted up by some injury or condition insufficient to determine a more violent form of inflammation. The synovial membrane becomes thick and infiltrated, whilst the effusion is sometimes relatively less than in the acute form, sometimes excessive, then constituting the condition described as *chronic serous synovitis* (Fig. 186). The pain is not so severe, being replaced by a sense of uselessness and weakness. It is interesting to note that, in cases where the effusion is well marked, the bursæ communicating with the joint frequently become distended; they are prevented from participating in the acute forms of inflammation by the fact that the apertures of communication with the interior of the joint are narrow and slit-like, and thus readily become occluded by the swelling of the membrane. Crepitus is sometimes met with in chronic synovitis, possibly from a roughening of the articular surfaces on which lymph has been deposited, or between which fibrous adhesions have formed.

Treatment consists in fixing the joint in a suitable position, and applying counter-irritation and pressure; blisters are especially useful in this affection. At a somewhat later stage, elastic pressure by a Martin's bandage may be employed, together with friction with stimulating liniments, or even hot-air baths. Removal of some of the fluid by aspiration and subsequent compression may also do good; but if the affection resists such treatment, the best procedure consists in opening the joint, washing it out with normal saline solution or with a solution of corrosive sublimate (1 in 4,000), and draining it for a few days.

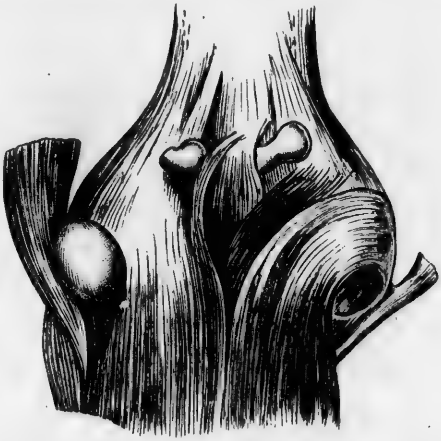

FIG. 187.—BAKER'S CYSTS FROM BACK OF KNEE. (HOWARD MARSH.)

Hydrarthrosis (Hydrops Articuli) is the term applied to any condition of a chronic nature in which the joint is much distended with fluid. It may arise from at least five different affections: (*a*) Chronic serous synovitis; (*b*) in osteo-arthritis, perhaps the most common cause; (*c*) in Charcot's disease; (*d*) in secondary syphilitic synovitis; and (*e*) very rarely in tubercular synovitis. It must be remembered that it is but a symptom, and not a disease *sui generis*, and treatment must be directed to the cause.

Baker's Cysts.

This condition, first described by the late Mr. Morrant Baker, consists in a hernial protrusion of the synovial membrane of a joint through an aperture in its fibrous capsule (Fig. 187). It usually arises in consequence of some chronic affection of the articulation, especially osteo-arthritis or tubercular disease, whereby the intra-articular pressure is increased, and not uncommonly several such sacs are met with in the same joint. They vary much in size, contain synovial fluid, and, though at first communicating with the joint cavity, have a tendency to travel away from it, burrowing along muscular and fascial planes, and coming, perhaps, to the surface some distance from their origin, the aperture of communication with the joint having in some instances been shut off. If causing no troublesome symptoms, there is no necessity to interfere; but if they become inconvenient or painful, it is easy to dissect them out, closing where necessary by ligature or suture the narrow neck which leads into the joint. Of course, the strictest asepsis must be maintained in all such proceedings.

Acute Arthritis.

By the term **Arthritis** is meant any inflammation of a joint which tends to involve all the structures of which it is composed, viz., bones, ligaments, cartilages, and synovial membranes.

Three distinct **types** of acute arthritis are met with, and may be described as follows: (1) *Acute rheumatic arthritis*, in which disorganization of the joint is produced as a result of rheumatic inflammation, and usually without suppuration; (2) *acute septic arthritis*, in which the inflammatory process is due, not only to pyogenic cocci, but also to the presence of non-pathogenic organisms, the infection coming from outside the body, and being usually due to a penetrating wound; (3) *acute infective arthritis*, in which pathogenic organisms alone reach the articulation from within or without the body. This may occur in several ways: (i.) It may be due to the entrance of cocci through a punctured or valvular wound of the joint, or during operations. It is interesting to note how extremely prone to inflammation is the synovial membrane when opened, even after the most careful antiseptic precautions. (ii.) It may arise in a manner exactly analogous to that in which acute infective necrosis of bone is produced; *i.e.*, the patient is in a low state of health, his natural germicidal powers are diminished, pyogenic organisms are present in the blood-stream, gaining access through some breach of surface, and, finally attacking any weak or damaged tissue, produce therein suppurative inflammation. A slight injury, *e.g.*, a sprain or strain occurring in a weakly child, convalescent from measles or scarlet fever, may result in this affection. (iii.) It may be produced by the lodgment of a pyæmic embolus, and in a similar way it not unfrequently follows as a sequela of fevers by direct transmission of some infective material. (iv.) It is sometimes met with as a result of gonorrhœa, and may then run its course with or without suppuration. (v.) It may be lighted up as a result of the extension of inflammation from the end of a neighbouring bone, or from the bursting of a subcutaneous or bursal abscess into the joint. Acute arthritis of the hip-joint is commonly due to the former of these conditions, being consecutive to an acute infective osteomyelitis of the upper end of the femur.

As to the **Bacteriology** of acute arthritis, several different forms of micro-organisms have been found. That most commonly present is a modification of the *Streptococcus pyogenes*, known as the *Strep. articulorum.* It is pathogenic to mice and rabbits, but not to guinea-pigs, and when injected into a rabbit seems to especially select the joints. Various other organisms have also been isolated, such as the *Staph. pyogenes aureus*, the *Gonococcus*, the *Pneumococcus*, and in septic cases a variety of non-pathogenic microbes.

Course of the Case.—In the early stages acute arthritis manifests itself as a hyperacute synovitis, combined with severe pain and fever. The pain is often so intense that the patient cannot bear the limb touched or the bed shaken, and indeed the slightest jar of the limb is so exquisitely painful that the patient may scream with agony. The joint itself is distended with a turbid effusion, which rapidly becomes purulent, and the tissues around are hyperæmic and œdematous. The patient naturally places himself in that position in which the limb obtains the greatest ease, and therefore usually semiflexes the joint and fixes it by muscular contraction.

As the disease progresses, pus is formed within the capsule, bursting through it, and either travelling directly to the surface, or burrowing deeply into the substance of the limb; thus, in the knee an enormous abscess may collect beneath the vasti muscles, stripping them from the bone for a considerable distance. The pain increases whilst the abscesses are forming, and becomes especially distressing at night, the patient being often waked by a painful start just as he has fallen asleep. This condition usually indicates that the articular cartilages are becoming affected, and is explained by the fact that, just as the patient loses consciousness, the muscles which fix the joint are relaxed, and allow the inflamed surfaces to slightly shift their position, exciting severe pain and a sudden spasmodic contraction of the muscles. Gradually the deformity becomes more and more obvious, whilst the infiltration and relaxation of the ligaments may sometimes allow of abnormal movements, *e.g.*, in the knee-joint, of lateral mobility; the ends of the bones become carious, and absolute displacement or dislocation may follow. Sinuses may open in all directions, and the patient suffer from recurrent rigors, caused by toxæmia or the onset of pyæmia. The constitutional effects are always severe, consisting of high fever, and rapid exhaustion from the pain, sleeplessness, and absorption of toxines.

The *terminations* of this affection are as follows: (*a*) Recovery, rarely with a moveable joint, and then only after active interference; in most cases ankylosis in a good or bad position, according to the treatment, is the best result that can be expected. (*b*) During the acute stage the patient may die of pyæmia, or acute toxæmia. (*c*) If he survive the acute stage, chronic suppuration may ensue, and symptoms of hectic and amyloid degeneration in the viscera may supervene. In such cases sinuses leading down to carious bone exist, and, unless efficient measures are taken to obtain asepsis, or to remove the diseased structures, the patient may die from exhaustion or chronic sapræmia.

Pathological Anatomy.—The *synovial membrane*, at first merely infiltrated and hyperæmic, soon becomes converted into granulation tissue from within outwards, exuding abundant pus. The *ligaments* in turn are sodden and relaxed by the presence of a plastic exudation between the fibres, rendering them soft and œdematous, so that the tonic contraction of the muscles easily stretches these and brings about displacement.

The *articular cartilages* are disintegrated and destroyed in various ways, according to the acuteness of the inflammation and the amount of pressure to which they are exposed. In acute cases they early lose their normal bluish-white appearance, and become opaque and slightly yellowish. The central parts, which are exposed to pressure between the ends of the bones, soon become disintegrated and disappear, whilst the peripheral portions are eroded by the growth of the granulation tissue developing from the synovial membrane. When once the cartilage has been perforated at any one spot, the suppurative inflammation spreads along its under surface, stripping it from the bone, and thus inducing necrosis, as a result of which isolated portions of dead cartilage may be found lying in the joint. In the more chronic forms of the disease, proliferation of the cartilage cells occurs, whereby the capsules become distended, and the matrix encroached upon; some of these cavities burst into the joint, and thus leave more or less flask-shaped openings into which pyogenic organisms find their way, and thus increase the mischief, whilst others extend towards the deeper aspect and become transformed into granulation tissue by vascularization from the vessels in the bone. In either way the cartilage is soon destroyed and replaced by granulation tissue, a proceeding analogous to ulceration of the softer parts.

The ends of the bone pass into a condition of acute osteitis resulting in transformation of the medulla into granulation tissue, absorption of the bony cancelli with or without suppuration, and sometimes necrosis of small portions of the cancellous tissue (caries necrotica). The veins within the cancelli become thrombosed, and hence pyæmia may result. The *periosteum* covering the ends of the bones is also inflamed and hyperæmic, in consequence of which spiculated or stalactitiform osteophytes are produced (Fig. 188). The *muscles* in the neighbourhood of the joint undergo rapid atrophy and fatty degeneration, probably as a result of some reflex disturbance of the trophic centres.

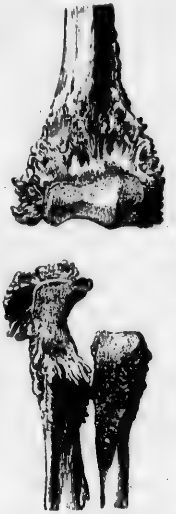

FIG. 188.—ENDS OF THE BONES AFTER ACUTE ARTHRITIS OF ELBOW, SHOWING THE CARIOUS SURFACES DEVOID OF CARTILAGE, AND THE DEVELOPMENT OF STALACTITIFORM OSTEOPHYTES. (FERGUSSON.)

Treatment.—In the early stages the limb must be elevated, absolutely immobilized, and put into such a position that, if ankylosis subsequently obtains, it may be of some use to the patient. Hot fomentations or an icebag may be temporarily applied, but as soon as the symptoms point to suppuration, the joint should be freely opened in one or two places, washed out with some sterile or antiseptic solution, and drainage-tubes inserted, whilst necessarily any peri-articular abscesses are dealt with in the same way. Openings should preferably be made on opposite sides of the joint, so as to allow the cavity to be frequently flushed out, or, if considered desirable, for continuous irrigation of the joint with some mild antiseptic (*e.g.*, weak boracic lotion, or sublimate solution, 1 in 8,000), or some bland unirritating fluid, such as sterilized normal saline solution. The fixation of the limb is maintained, and the general health attended to. This treatment should be continued until all signs of inflammation, pain, heat, and startings of the limb, have passed away. Under such a regime it is sometimes possible to obtain a moveable joint, but more frequently ankylosis must be expected. If the patient is suffering from severe pyæmic symptoms threatening life, amputation may be required, as also for exhaustion from long-standing suppuration and hectic fever; in some cases of chronic suppuration, with caries of the ends of the bones, and displacement, excision may be undertaken, but not until all acute symptoms have passed away.

In the rheumatic cases where suppuration is not expected or does not threaten, the joint should be elevated and kept absolutely at rest; counter-irritation by means of blisters, or even the actual cautery, may be useful, whilst suitable constitutional treatment is adopted.

Acute Arthritis of Special Joints.

In the **Shoulder**, infection sometimes occurs through the axilla where the capsule is weak and easily penetrated by organisms, as after an axillary cellulitis; more frequently, however, it follows a penetrating injury. There is always severe pain owing to any movement of the arm affecting the joint, and the pus in the distended synovial membrane comes to the surface in front or behind the deltoid, or in the axilla. It may suffice to open the articulation anteriorly and flush it out, but, if possible, a counter-opening should be made behind by cutting down on a pair of dressing forceps pushed backwards through the capsule. In many instances the patient's condition will not improve until the head of the bone has also been excised. The subsequent results as regards movement and power of the arm are, on the whole, extremely satisfactory.

In the **Elbow**, there are no points requiring special mention as to clinical history or results, although it must be remembered that the superior radio-ulnar articulation is necessarily involved, and hence the power of pronation and supination of the hand is threatened. As to treatment, incisions should be made on either side of the olecranon, the ulnar nerve being avoided. The limb is then placed on a rectangular splint, and with the hand midway between pronation and supination; of course, the patient is kept in bed, with the arm raised on a pillow. In an adult excision may be undertaken as soon as the acute stage has passed, in order to obtain a moveable elbow; but in children, where the growth is incomplete, it is better to allow ankylosis to occur, and excise, if need be, at a later date.

The **Wrist** may be infected secondarily to septic conditions following operations on ganglia in the neighbourhood, or through direct injury. The essential treatment consists in free incisions parallel with the tendons, and avoiding the sheaths. Ankylosis usually results, and excision is not resorted to except when the disease has become very chronic, with extensive caries of the carpus.

Acute arthritis of the **Hip-joint** is usually a sequela of acute infective osteo-myelitis attacking the upper end of the shaft of the femur, and involving the joint owing to the epiphyseal cartilage being intracapsular; it also results from pyæmia, and rarely from penetrating injuries. The symptoms are similar to those of the first stage of ordinary tubercular disease (p. 593), but much more acute. There is high fever, together with intense pain, marked flexion and eversion of the limb, early suppuration, and rapid disorganization if not properly treated; indeed, where nothing is done, and the patient lives long enough, the head of the bone may be entirely absorbed, or is detached and remains as a sequestrum in the disintegrated articular cavity. As soon as the capsule gives way, the pus may come to the surface in any of the usual localities for hip-joint abscesses. In treating these cases, the joint should be freely laid open in the situation which appears most favourable. The anterior incision is more suitable for the early, and the posterior for the later stages, when the head of the bone is either dislocated, or remains *in situ* and separated from the shaft. A double opening may sometimes be utilized with advantage.

The **Knee-joint** is more frequently involved by this disease than any other, and is usually infected from without. The symptoms are exceedingly typical: there is great pain and heat of the joint, which is distended to its utmost capacity, the limb lying semiflexed and on its outer side. Left to itself, the capsule gives way, and suppuration rapidly extends upwards beneath the vasti or downwards into the leg, ultimately finding its way to the surface. The deformity gradually increases, until in the worst forms the tibia slips behind the condyles of the femur, the leg is flexed to a right angle and rotated outwards, and if the limb has long rested on its outer side, considerable lateral displacement may also occur. Early and efficient treatment will usually prevent such a disaster. The joint should be freely incised on each side of the patella, so as to open up the crureal pouch, and the whole articular cavity well washed out. In some cases a counter-opening may be made with advantage and a drain-tube inserted, by passing a pair of sinus forceps through the outer portion of the posterior ligament of Winslow, and cutting down on it to the inner side of the biceps tendon and clear of the external popliteal nerve. By this means more efficient drainage of the articular cavity is obtained.

When the **Ankle-joint** is involved, amputation has often to be resorted to, in consequence of the difficulty of securing good drainage.

For arthritis of the **Temporo-maxillary** joint, see p. 679.

Tubercular Disease of Joints.

Tubercular Arthritis (*syn.*: **Pulpy Degeneration of the Synovial Membrane, White Swelling**, etc.) may commence either in the synovial membrane or in the articular end of the adjacent bone (tubercular epiphysitis in young children, p. 535); or it may spread from the periosteum to the synovial membrane, as a result of a tubercular periostitis, or from a neighbouring bursa. The synovial origin is more common in children and adolescents, the osseous in adults.

The **Causes** may be summed up as follows: The individual is predisposed to the development of tubercular disease, usually as the result of a hereditary tendency, a family history of tubercle being often obtainable; the general health of the patient may be at fault, owing to insufficient or inappropriate food, bad hygienic surroundings, or exposure to cold; it occasionally follows as a sequela of one of the exanthemata. Some slight injury of which but little notice is taken may lead to the actual deposit of the *Bac. tuberculosis*, which gains access to the body through some breach of surface, or even perhaps through a healthy mucous membrane. Severe articular lesions, such as dislocations, are much less likely to induce tubercular disease, partly because their gravity demands efficient treatment, partly because the activity of the reparative process is capable of dealing with the organisms, even if they are brought to the spot.

Pathological Anatomy. — The *synovial membrane* becomes thickened, pulpy, and œdematous, and in the early stages, on naked-eye examination, may be found to be studded with small gelatinous nodules, about the size of a pin's head, situated immediately beneath the serous lining; later on these may amalgamate into caseous masses which burst and discharge into the joint, leaving ulcerated surfaces. Finally, the synovial membrane is changed into a kind of pyogenic membrane, similar to that lining the cavity of a chronic abscess, more or less

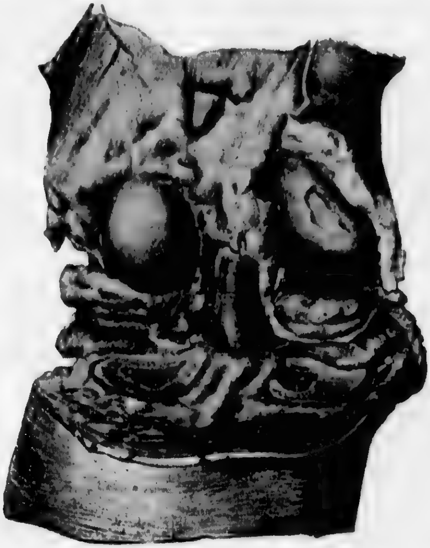

Fig. 189.—Tubercular Disease of Knee, showing the Synovial Membrane overlapping the Cartilage, which is eroded and in Parts detached from the Bone and Necrosed. (From College of Surgeons' Museum.)

closely attached to the surrounding tissues, which are transformed into œdematous fibro-cicatricial tissue, whilst the superficial parts undergo various forms of fatty or necrotic degeneration (Fig. 189). Microscopically, one finds all the ordinary appearances of tubercular disease, the vessels being in a state of endarteritis for some distance from the serous surface. Fringes of the synovial membrane, swollen and succulent, spread over the margins of the *articular cartilage*, and as they increase in size become adherent to it, just as, according to Billroth's classical description, ivy creeps along a wall. On lifting the edges of these fringes, the underlying cartilage is found hollowed out and eroded. As soon as the whole thickness is destroyed at any one spot, the cancellous tissue at the *end of the bone* becomes similarly affected, and the granulations are able to spread along the under surface of the cartilage, cutting it off from its nutritive supply, and thus necrosis, as well as superficial ulceration, may assist in its destruction. As a result of the hyperæmic condition of the end of the bone, a new formation of subperiosteal osteophytes, stalactitiform in character, sometimes takes place. Occasionally the periosteum itself is involved in the tubercular process, and the disease may then extend some distance from the joint.

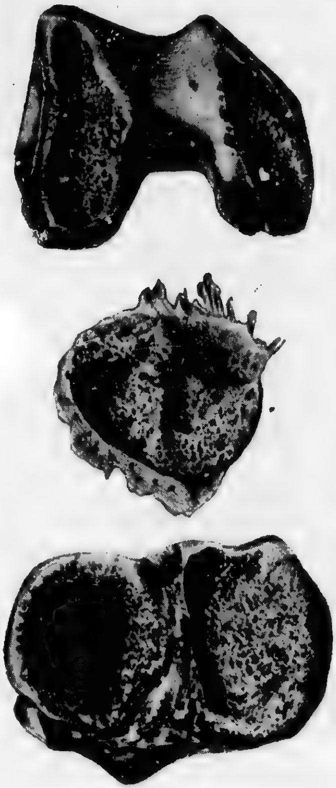

FIG. 190.—BONES ENTERING INTO FORMATION OF KNEE-JOINT, WHICH HAS BEEN DISORGANIZED BY TUBERCULAR DISEASE. (FROM COLLEGE OF SURGEONS' MUSEUM.)

The cartilage is almost entirely destroyed, and the exposed bone is carious and eroded.

When the bone becomes involved, either primarily or secondarily, any of the manifestations of tubercular disease described in Chapter XVIII. may be met with, and thus it is not uncommon to find sequestra in connection with tubercular arthritis. When it originates in the bone, the tissue immediately contiguous to the epiphyseal cartilage is often that primarily attacked; but sometimes it starts immediately beneath the articular cartilage, which is gradually eroded, and the articulation thus involved.

Clinical History.—The disease usually commences in a most insidious manner. It may be dated back to some injury, but as often as not no such occurrence has been noted. Slight impairment of movement, together with some pain, especially when the limb is jarred or twisted, is perhaps the first sign, causing the patient to limp if one of the lower extremities is involved. This becomes more and more marked, and the joint is fixed, usually in a semiflexed position, whilst it looks slightly swollen. On inspection it is white, smooth, and rounded, the swelling being more marked on account of the wasting of adjacent muscles. On palpation, the part is found to be hotter than that on the opposite side of the body, whilst fluctuation is not readily detected, the swollen tissues being elastic and puffy. In a few rare cases, where the synovial membrane is widely affected, there is a considerable serous exudation, constituting a condition known as tubercular hydrops. After persisting for a while, the usual manifestations of the disease show themselves.

From time to time exacerbations of pain and increase of swelling occur, which subside after a few days, but leave the joint more and more crippled. Sooner or later abscesses are likely to develop, with increased local disturbance, and often starting pains at night, due to the erosion of cartilages, together with slight general fever and malaise. If they burst, temporary relief follows; but as the discharge continues, and fresh abscesses form, septic phenomena are added to those already existing. The patient develops a hectic temperature; amyloid degeneration of the viscera may supervene, the joint becomes more and more deformed, abnormal movements from relaxation of ligaments may exist, and finally the patient, exhausted partly by the discharge, partly by the pain, and partly by the want of sleep, becomes emaciated, and, unless prompt measures are taken for his relief, may even die.

Results.—(*a*) If taken in the early stages, and suitably treated, the disease may be entirely cured, and a moveable joint result. (*b*) More frequently the articular structures are so severely damaged, that a cure can only be established by means of ankylosis. Unless measures have been taken to maintain the limb in a satisfactory position, permanent deformity may ensue. (*c*) If the sinuses have become septic, the patient will probably develop hectic or amyloid disease from chronic toxæmia, and from this he may succumb. On the other hand, in a few instances he may survive such dangers, the sinuses alternately drying up and discharging, although he remains a permanent invalid, and the joint is crippled. (*d*) Acute miliary tuberculosis is often met with as a complication of this affection, whilst similar associated disease of the lungs, brain, kidneys, or other viscera, may be lighted up.

The **Prognosis** is mainly influenced by the condition of the individual and his surroundings. In children of the better classes, where every hygienic and medical assistance can be given, recovery generally follows, unless there is a counterbalancing hereditary tendency. Amongst the poorer classes, and especially in 'slum children,' the outlook is correspondingly serious. Moreover, the extremes of life are unfavourable: babies resist tubercular invasion badly, and patients over fifty have comparatively little recuperative power; hence radical rather than conservative measures have often to be resorted to in these two classes.

The **Treatment** of tubercular joints varies not only with the articulation affected, but also with the type of patient, and the extent to which the disease has advanced.

1. *Hygienic Treatment.*—Local tuberculosis is a manifestation of a general condition of weakness which can often be eradicated from the system by suitable constitutional treatment; it is not like cancer, over which natural processes have no control, and for which the only hope of cure lies in the complete removal of the disease with the knife. Consequently, in the early stages, many cases of tubercular synovitis can be cured by keeping the limb absolutely at rest, by means of splints, plaster of Paris, etc., and elevating it if there be much pain. The general health should be improved by sending the child to the seaside, giving it plenty of good food, and administering cod-liver oil and syrup of the iodide of iron. An endeavour must be made at the same time to correct any faulty position of the limb by a process of gradual extension (combined, if need be, with tenotomy) rather than by the sudden application of force, whereby tubercular material may be disseminated through the system. The cure takes time, and hence cannot always be carried out amongst hospital patients. Counter-irritation by blistering or iodine paint is sometimes useful in promoting repair, but should not be persevered in too long. Possibly the severe pain experienced when the contiguous osseous tissues are involved may be relieved by an application of the actual cautery, but it is doubtful whether the progress of the disease can be thereby checked.

2. *Parenchymatous injections* of iodoform suspended in glycerine into the articular cavity, or into the substance of the synovial membrane, have been much recommended of late, and seem to have done good; 10 parts of iodoform are mixed with 20 of sterilized water, and made up to 100 with pure glycerine, and about an ounce of this fluid is injected. The limb is at the same time immobilized, and possibly some massage is employed from time to time. The injection usually needs to be repeated more than once. β-naphthol and some other antiseptics have also been employed in a similar fashion. The treatment of tubercular abscesses by this method has been most successful.

3. A new plan of treatment was suggested by Professor Bier of Kiel a few years back; it consists in inducing *venous engorgement* of the diseased tissues by applying an elastic bandage above and below the joint, but only loosely over it; the pressure is kept on for two or three hours daily, if the patient can bear it, and during the intervals a splint is applied. The general health must also be attended to during the treatment. The process is based on the observation that phthisis rarely develops in association with mitral regurgitation, whereby pulmonary engorgement is induced; whilst if the cardiac lesion occurs in a phthisical subject, the lung symptoms improve. It is too early yet to say what the final verdict as to this method will be, but the results hitherto gained are encouraging.* It must never be employed when septic sinuses are present, as it considerably aggravates the trouble by providing increased pabulum for the micro-organisms.

4. If, in spite of hygienic measures, the symptoms persist or become more marked, or if abscesses form without much evidence that the ends of the bone are irretrievably injured, or if the case is not seen in quite the early stages, a simple *arthrotomy* may give relief, and if the opening thus produced is kept aseptic, and the other local and general treatment maintained, a cure with ankylosis may finally result. The joint or the abscess should be freely incised in one or more places, any accessible granulation tissue removed by scissors or sharp spoon, iodoform injected, and the cavity either plugged with gauze, or partially closed and suitably drained.

5. In other cases where expectant treatment cannot satisfactorily be carried out, or where the disease is very extensive, *arthrectomy*, or total removal of the diseased tissues with the least possible disturbance of the parts, should be undertaken. This treatment is only feasible in certain joints, viz., the elbow, knee, and ankle, which can be readily reached, and more or less efficiently dealt with. It consists in freely opening the articular cavity, and cutting or scraping away the diseased membrane, whilst carious cavities in the bone are scraped and purified. The advantages claimed for it are, that it interferes neither with the immediate length nor with the subsequent growth of the limb; moreover, no bone is cut through, and hence risk of tubercular infection of this structure is avoided, whilst in rare cases a moveable joint may be subsequently obtained. As to its practical value—if the proceeding is limited to the synovial membrane, we have little confidence in it, recurrences being frequently met with; but if it is modified by the additional removal of a thin slice of articular cartilage, so that it is converted into a limited excision, and osseous ankylosis between the two epiphyses is obtained, good results may be anticipated. At the knee, however, there is some tendency to subsequent flexion and displacement.

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* 'Archiv. f. Klin. Chirurgie,' vol. xlviii., bd. ii., p. 306.

6. *Excision* may be required under the following circumstances: (*a*) To cut short the course of the disease in those individuals where constitutional and expectant treatment cannot be efficiently carried out; (*b*) where such treatment has failed to check its progress; (*c*) where abscesses have formed and the disease has extended to the bones; (*d*) for total disorganization of the joint; and (*e*) to remedy ankylosis in a faulty position. In determining whether or not excision is advisable, the following considerations must be passed under review: (i.) The operation makes a considerable call upon the recuperative powers of the individual, and hence is not to be recommended in young infants or in patients of advanced age. Various age limits are given by different authorities, but, speaking generally, we would say that the operation should only be undertaken upon those between five and forty-five years of age. In infants arthrotomy, or at most arthrectomy, is all that is practicable, and, failing that, amputation; the close proximity of the epiphyses and the impairment of growth which would necessarily follow surgical interference with them contra-indicate excision in such cases. Where the hip-joint is involved, however, removal of the head of the femur often gives excellent results even in the young. The latter limit depends more on the vitality than on the actual age of the individual, whilst some joints are more amenable to excision in elderly patients than others; thus, one would excise the knee and shoulders in cases where one would not think of dealing with the wrist, ankle, or elbow in this manner. (ii.) Moreover, the general health of the individual must be sufficiently good, otherwise repair will not be satisfactorily accomplished. Hectic and amyloid disease, unless very advanced, do not contra-indicate this proceeding, but in weakly children living in the slums it is often better practice to amputate. (iii.) The extent of the disease in the bones is also a matter of importance, since, if a large amount of bone has to be removed, a shortened or flail-like, useless limb is almost certain to follow. More bone can, however, be removed without detriment in the upper than in the lower extremity. (iv.) Again, the disease must not have invaded the soft parts too extensively, and if the skin is unhealthy and riddled with sinuses, removal of the limb is often preferable. (v.) Finally, no acute or subacute septic trouble should be present, for fear of similar septic disease being set up in the bones. Under such circumstances the limb may sometimes be saved by making free incision to relieve tension, deferring excision until the more active symptoms have subsided.

7. If, after carefully weighing the preceding considerations, excision is not thought desirable, *amputation* would appear to be the only treatment available. In addition, it is indicated in cases where excision has been undertaken and failed, either from the limb becoming subsequently flail-like or useless, or from recurrence

owing to incomplete eradication, or from the advent of sepsis. Lastly, if a patient is suffering from this disease in two joints at one time, or in a joint and some other organ, neither of which is improving, total removal of one focus of mischief will often induce a rapidly favourable change in the other.

As regards tubercular disease in the various joints, the following facts may be stated:

The **Shoulder-joint** is but rarely affected in children, and not very commonly in adults. The disease usually starts in the head of the humerus, affecting subsequently the synovial membrane, and perhaps also the glenoid cavity. If abscesses form, they tend to point either in front or behind the deltoid, in the former case extending along the synovial membrane lining the bicipital groove. Excision of the head of the bone is almost always required in order to effect a cure.

In the **Elbow-joint** the disease starts in children most commonly in the synovial membrane, and then usually in that portion placed within the superior radio-ulnar articulation; in adults it is often primarily osseous, commencing most frequently in the olecranon or lower end of the humerus. Sinuses form on either side of the olecranon, or an abscess may burrow upwards along the ulnar nerve and open on the inner side of the arm. Prolonged immobilization, followed, if need be, by incision and partial removal of the synovial membrane, will often suffice in children, leaving, however, a stiff elbow; in adults excision is the correct practice, and the results are very satisfactory, provided that a sufficient amount of bone is removed, and the muscular attachments interfered with as little as possible. If expectant treatment is adopted, the arm should be flexed to a right angle, and with the hand midway between pronation and supination, so that, if ankylosis follows, the limb may be in the most useful position. Arthrectomy is occasionally required, and is best accomplished by means of an H-shaped incision over the olecranon, which process of bone is divided at its base and turned upwards, so as to thoroughly expose the interior of the articulation. After removing all diseased tissue, the olecranon is replaced and wired to the shaft of the ulna.

In the **Wrist** diffuse disease of the synovial membrane and bones is met with, starting most frequently from the former structure; it may also extend from a tubercular affection of the adjacent tendon sheaths. A characteristic doughy swelling forms over the dorsum, displacing the extensor tendons, and sinuses often develop on the dorsal aspect or by the side of the flexor carpi radialis tendon. Prolonged rest may bring about a cure, but early excision in suitable cases gives satisfactory results; since there is a great tendency to the production of a weak and flail-like hand, the constant use of a leather support is essential after healing has occurred. In elderly people amputation is the only resource.

Diseases of the **Hip-joint** and of the **Sacro-iliac Articulation** are separately considered (pp. 591 and 597).

The **Knee-joint** is, perhaps, more often affected with tubercular disease than any other articulation. Under ten years of age a synovial origin is the most common; between ten and twenty the osseous and synovial forms are about equal; whilst after twenty years the osseous variety is more usually met with, generally starting on the inner aspect of either the femur or tibia. Sequestra are found in nearly one half of the cases in which the bone is affected. The disease runs a typical course, and needs no special comment. When the joint has become disorganized, the tibia is displaced horizontally backwards, flexed and externally rotated, and ankylosis in this position is difficult to remedy, even by operation.

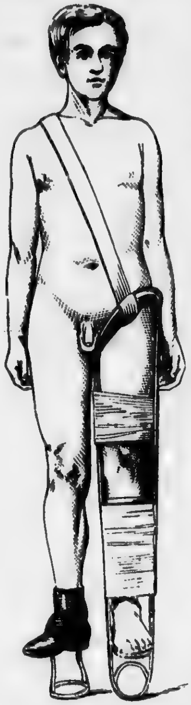

FIG. 191.—THOMAS'S KNEE-SPLINT APPLIED.

Prolonged immobilization on a back-splint, or, preferably, the application of a Thomas's knee-splint (Fig. 191), together with constitutional treatment, will be effectual in many early cases. At a later date a modified arthrectomy may be undertaken, and to carry it out an incision should be made across the front of the joint from condyle to condyle, as for an excision, dividing either the ligamentum patellæ, and thus opening the joint, or perhaps dividing the patella, which is subsequently wired together. The whole of the synovial membrane is then dissected out, special attention being directed to the subcrureal pouch and the back of the joint. A thin slice should be removed from the surfaces of both tibia and femur, and if the epiphyseal cartilages are not encroached upon, the growth of the limb is not subsequently impaired to any great extent, though some flexion may subsequently follow, owing to an irregular growth of the bones. In suitable cases, where the disease has not extended far into the bones, so that on section broad healthy surfaces can be apposed, excision is a most satisfactory operation, provided that the bulk of the synovial disease can be removed. Recurrence usually results from a focal point of disease being left in the synovial membrane or in the bone, particularly in those whose health has not benefited by the operation. If amputation is necessary, the supracondyloid operation can be advantageously adopted; but if the joint has been already resected, or sinuses still persist in front, amputation by a long posterior flap is the best, and sometimes the only feasible, method to employ.

The Ankle-Joint.—Tubercular disease of this joint usually commences in the synovial membrane rather than in the bone. If primarily osseous, the astragalus is more frequently affected than the lower end of the tibia. The whole region becomes occupied by a pulpy swelling, and abscesses generally point on one or other side of the tendo Achillis. In the early stages prolonged rest, combined possibly with arthrotomy, is all that is needed. Excision of the joint gives fairly satisfactory results, but not unfrequently fails to eradicate the disease, owing to the fact that, when once the astragalus is involved, the tubercular process is likely to spread to the articulations placed on its under side, and so to the other bones of the foot. When there is any doubt as to the condition of the astragalus, that bone should be removed at the same time as the lower ends of the tibia and fibula. Where the disease is more extensive, a supramalleolar amputation of the foot will be necessary.

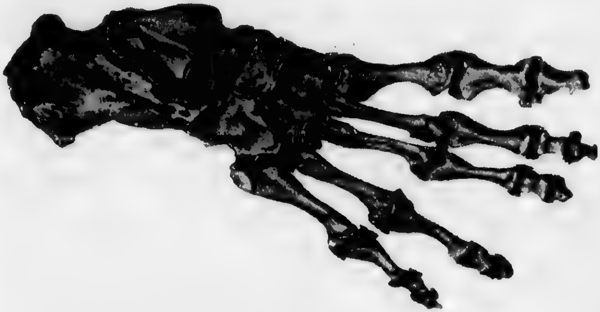

FIG. 192.—ARRANGEMENT OF SYNOVIAL MEMBRANES OF FOOT.

Disease of the **Bones and Joints of the Foot** is frequently met with in children, and, owing to the complex arrangement of the synovial membranes (Fig. 192), is always a serious affection, not unfrequently calling for amputation. It must be remembered, however, that the prognosis is much worse when the disease affects the inner half of the foot, comprising the astragalus, scaphoid, cuneiform, and the three inner metatarsal bones, than when it involves the outer segment, which consists of the cuboid and two outer toes. In the inner half of the foot conservative treatment is of little avail, except in the earliest stages, when, perhaps, prolonged rest, or a free opening of the articulation, if an abscess forms, and, perhaps, removal of the scaphoid, may check the process. In the outer half of the foot, treatment by scraping and purification, as for tubercular disease elsewhere, may be sufficient. If amputation is required, a Syme's operation, by which the whole of the foot is removed, is preferable to a Pirogoff, or any other proceeding whereby a portion of the tarsus is left behind.

Syphilitic Diseases of Joints.

Although syphilitic disease of joints is rare in proportion to the prevalence of syphilis, yet several varieties have been differentiated and recognised. (1) In the later stage of the secondary period a *chronic* form of *synovitis* occurs, evidenced by passive effusion into the joint, with or without pain, which usually persists for some time. Any joint may be attacked in this way, perhaps the knee most commonly, and the affection is often symmetrical in its distribution. The effusion may be only slight, but is frequently very considerable (hydrarthrosis), and a marked feature in the condition consists in the rapid variations in the amount of swelling, even from day to day. In some few cases this affection resists all treatment, and leads to ultimate disorganisation of the joint. (2) Gummatous inflammation of the perisynovial fibrous tissue, which may or may not extend to the adjacent bone, may be met with in the tertiary period. It either appears as a localized hard nodule, resembling in measure a fibrous tumour, and then causing but little trouble beyond a sense of painful weakness in the articulation; or is more diffuse in its distribution, leading to a moderate effusion into the joint, and later on to much thickening and infiltration of the capsular and other ligaments, resulting in considerable impairment of its movements from cicatricial contraction. Some of these gummatous nodules may break down and ulcerate. (3) A diffuse *gummatous infiltration of the synovial membrane* itself is also seen. It closely simulates a tubercular synovitis, from which it is often impossible to distinguish it, except by the rapid onset and the presence of other syphilitic phenomena. (4) A *chondro-arthritis*, described originally by Virchow, is the syphilitic analogue of osteo-arthritis. It commences by fibrillation of the matrix of the cartilage, and proliferation of the cells. The cartilage softens, and becomes eroded by friction of the articular surfaces. The bone thus exposed is worn away, and curiously 'pitted' and excavated. It is recognised from osteoarthritis by the facts that there is, as a rule, but little or no pain; that the eburnation of the exposed bone is less extensive; whilst the typical osteophytic growths causing 'lipping' of the joint margin are absent. The eroded areas, moreover, do not correspond with the sites of intra-articular pressure, and are more rounded and punched out, and not arranged in linear grooves, as in the latter disease. It is not uncommonly associated with a gummatous thickening of the synovial membrane, and, indeed, the hollows or pits above mentioned may be filled with caseous material, derived from degeneration of this tissue.

The **Treatment** in the early manifestation consists in the administration of mercury, and the judicious application of pressure with or without immobilization, according to the requirements of the case and the joint affected. In the tertiary forms iodide of potassium in gradually increasing doses has a rapidly beneficial action, which confirms the diagnosis; it may be occasionally combined with a small amount of mercury, either given internally, or applied locally if any ulcerative lesion exists. In the most pronounced cases, where the pain is severe and disorganization of the joint has occurred, excision may be necessary, and the results are often very satisfactory.

Osteo-arthritis.

Under this heading we propose to describe a disease which is very common in this country, and has well-marked characteristics; its nature is still very obscure, although possibly some light has been thrown upon it of late. The large number of names which have been applied to it from time to time are sufficient evidence of the differences of opinion which have been expressed as to its pathogenesis; thus, amongst the synonyms we note *chronic rheumatoid arthritis*, *rheumatic gout*, *arthritis deformans*, *arthritis senilis*, *arthritis sicca*, etc.

There can be but little doubt that several distinct affections are grouped together under this heading, and until we are able to differentiate them no great advance will be made. The following varieties can certainly be distinguished: (*a*) *Chronic rheumatic arthritis*, a condition resulting from true rheumatic changes in and around a joint, and usually characterized rather by synovial and capsular changes than by cartilaginous or osseous phenomena, although these may be superadded at a later date. (*b*) *Chronic traumatic arthritis* is an affection of the joint which may supervene after any type of injury, whether slight in nature, as from sprains or strains, or more serious, as from fractures implicating the articular ends of the bone, *e.g.*, Colles's fracture, or intracapsular fracture of the neck of the femur or humerus. The pathological changes here are indistinguishable from those of the true osteo-arthritis. (*c*) Occasionally in *gout* the same series of processes are lighted up, especially where there is a considerable deposit of urate of soda in the peri-articular tissues. (*d*) Finally, we come to the condition which we must consider as the typical form of *osteo-arthritis*.

The **Causes** of true osteo-arthritis are in many cases to be looked for in exposure to damp and cold, especially when a depressed condition of the nervous system is also present, whether such be due to worry, anxiety, or to defective nutrition. There can also be little question that in some cases it is to be considered as a disease of nervous origin, resulting from peripheral neuritis, or other similar degenerative changes in the nervous system. The nerves supplying the affected joints have in a few cases been shown to be in a state of chronic neuritis, but of course it is difficult to prove conclusively that both affections are not independently due to the same originating cause. Heredity is an important factor in many instances, and it is frequently noticed at an early age in the children of parents who suffer from it. Recently a theory of bacterial origin has been propounded, and although this cannot at present be considered as proved, yet the observations that have been made are exceedingly interesting, and, if confirmed by further investigation, will put the disease in quite a new light. It has long been suspected that acute rheumatism is due to microbic activity, and several observers, especially Bannatyne, of Bath, have also found that organisms in the form of small bacilli are present in the synovial effusion in this disease.

Pathological Anatomy.—The disease commences in the articular cartilage, the matrix of which cracks and undergoes fibrillar changes, and presents a villous appearance, resembling the pile of velvet (Fig. 193). The cartilage cells proliferate, so that the capsules contain many instead of one, and these, giving way, discharge their contents into the joint. The cartilage thus softened is readily worn away by the movements of the articulation, and the exposed surface of bone becomes hard, sclerosed, and polished like ivory (eburnated). This usually occurs in certain definite directions. In hinge joints the surfaces become grooved longitudinally, whereas in ball-and-socket joints, like the hip, the head of the bone is eroded in a circular manner. This condensed tissue does not extend very deeply. Immediately beneath it the cancellous bone is of a more open texture than usual, and filled with fatty medulla. In spite of the sclerosis, the articular end of the bone is continually being worn away, and this may go on to such an extent as to lead to actual shortening of the limb. Concurrently with this destruction, new bone formation is taking place at the margins of the articular cartilage, producing irregular osteophytes, which have been likened to the gutterings of a candle. They are preceded by an overgrowth of cartilage, in which ossification takes place secondarily. When such outgrowths have been produced more or less evenly around the joint margin, a characteristic 'lipping' of the edge of the cartilage results (Fig. 194). Sometimes these osteophytes attain to a large size, and by interlocking may lead to ankylosis of the joint. The synovial membrane is usually thickened, and

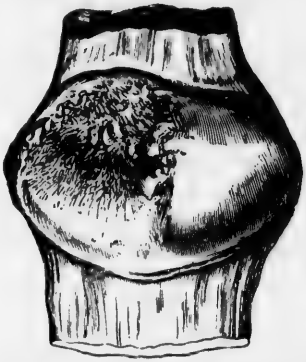

FIG. 193.—PATELLA FROM EARLY CASE OF OSTEO-ARTHRITIS, SHOWING FIBRILLATION OF CARTILAGE. (HOWARD MARSH.)

the villi occasionally proliferate, and may reach such dimensions as to be felt through the skin, rolling under the finger. They are red, vascular, and succulent during life, but after removal and preservation in spirit, they look shrunken and insignificant. This overgrowth is often associated with excessive effusion, though usually the affection is of a dry type. Occasionally cartilaginous nodules develop in the villi of the synovial fringes, later on becoming ossified, and if detached constitute one form of loose cartilage (*q.v.*).

Symptoms.—Pain and creaking of the joint on movement are the early symptoms of this affection. There may be very little swelling, unless effusion is present, but pain, especially at night, is most troublesome, being usually increased on changes of weather, particularly if rain is threatening. The pain and stiffness are most marked after keeping the parts at rest, and diminish as the limb is used. As the disease progresses, the movements become more and more impaired, and the crepitus more of an osseous type; the ends of the bones may be felt enlarged and lipped, and deformity soon becomes obvious. Exacerbations in the symptoms occur from time to time, resulting in increased crippling of the articulation. Finally, the limb may become absolutely useless, partly from the pain and partly from the limitation of movement produced by the osteophytes. Wasting of the adjacent muscles is also a marked feature.

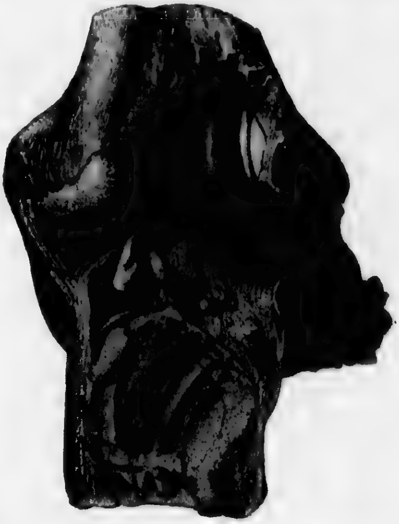

FIG. 194.—LATE STAGE OF OSTEO-ARTHRITIS OF KNEE, SHOWING DESTRUCTION OF THE ARTICULAR CARTILAGE, AND EBURNATION OF THE EXPOSED BONE IN LONGITUDINAL GROOVES. (FROM COLLEGE OF SURGEONS' MUSEUM.)

The margins of the surfaces are distinctly lipped.

Any joint may be affected, but if the smaller ones are first attacked, the affection may only spread gradually to the larger, whilst if it commences in a large joint it often remains monarticular. The *poly-articular* variety usually selects the fingers, and produces in them a characteristic ulnar adduction, especially in young people. The joints can be felt enlarged, and often near the base of the last phalanx are distinct nodular bony outgrowths, known as Heberden's nodosities. Not unfrequently a certain amount of febrile disturbance, with increased rapidity of the pulse, is noticed before or during the outbreak of the attack. The *monarticular* variety affects both the old and young; in the former, bone formation and bone destruction are present to a much greater degree than in the latter. As a rule, there is but slight effusion, but occasionally a condition of hydrarthrosis is present, associated with overgrowth of the synovial villi.

The **Diagnosis** of osteo-arthritis *per se* is not usually difficult, the crepitus, typical pain, and enlargement of the ends of the bones, together with the slight amount of effusion, constituting a tolerably characteristic picture. From simple chronic synovitis it may be known by the history and smaller amount of effusion, and by the pain and rigidity being frequently more marked after rest, and diminishing after the joint has been actively used. There is more difficulty in distinguishing the form associated with increased effusion and enlargement of the synovial villi; careful examination may, however, enable the surgeon to make out these villi moving to and fro in the joint under his hand, whilst possibly the ends of the bone may be lipped. The rheumatic and traumatic forms are mainly dependent for their diagnosis on the history, although in the former the marked early rigidity and absence of osseous phenomena may assist. For diagnosis from Charcot's disease, see p. 584.

The **Prognosis** is usually unfavourable, especially in what we have termed true osteo-arthritis. The fact that many joints are affected is an indication that there is a considerable constitutional tendency to the development of the disease, and although it may be temporarily combated with success, still, sooner or later, the patient is almost certain to be crippled by it. The affection of only one joint often points to a traumatic origin, and the outlook is correspondingly brighter. In the rheumatic variety the prognosis is good if early and efficient treatment is undertaken, and if only one joint is involved; but where the disease attacks several parts of the body, there is but little hope of checking it, and indeed cases are known in which every joint has successively become implicated, the patient dragging on a weary existence, never free from pain, and usually in a cramped or sitting posture until death from exhaustion supervenes.

Treatment.—For this troublesome complaint there is, unfortunately, little that can be effected in the way of cure, although much can be done to alleviate. Locally, the articulations should be protected from cold and injury by being swathed in flannel, whilst stimulating embrocations and sedative applications may be beneficially employed. It is not advisable to maintain the joints absolutely and always at rest, otherwise they tend to become fixed, and the patient's movements seriously limited at an unnecessarily early date. Moreover, it is often found that the more a joint is moved, the easier and less painful do those movements become. As to general treatment, the individual is warned against exposing himself to cold and damp, and, since the disease is often considered to be due to perverted or diminished nervous activity, all possible sources of irritation and worry should be removed. At the same time the diet should be carefully regulated, and where a rheumatic or gouty history is present the dietary suitable to those diseases may be ordered. A large number of different drugs have been tried for this complaint, but none of them are very satisfactory. Perhaps the best is iodide of potash combined with some alkaline purgative and hepatic stimulant, such as sulphate of soda. Natural mineral waters and baths are often beneficial, those of Bath and Buxton in this country being most frequently recommended. Arsenic is sometimes useful in cases where the disease is probably of nervous origin.

Occasionally operative treatment in the shape of *excision* may be useful in this complaint, but only when the disease is limited to one joint, and when it has progressed to such a stage as to seriously cripple the patient's usefulness, as in the knee-joint or the shoulder, or when the act of mastication is impaired, owing to an affection of the temporo-maxillary articulation. In suitable cases excellent results are obtained.

In the rheumatic variety counter-irritation in the form of frequently repeated blisters, or even of the actual cautery, may prove beneficial; whilst both in it and in the traumatic affection localized hot-air baths may be used with advantage.

The *hip-joint* is not uncommonly the seat of osteo-arthritis in old people, and it always causes a considerable amount of pain, especially on flexion of the limb, rendering sitting difficult and walking uncomfortable, whilst the movements become steadily more and more curtailed. The limb appears to be slightly increased in length at first, but later on becomes shortened from erosion of the head and atrophy of the neck of the bone; the trochanter is also much thickened and more prominent than usual, on account of the associated atrophy of the neighbouring muscles. Well-marked crepitus is obtained on moving the thigh. The acetabular cavity is increased in size owing to the formation of a projecting rim or lip. If a patient falls on the affected hip, some difficulty may be experienced in making a diagnosis from fracture of the neck of the thigh-bone. The previous history and the facts that the trochanter rotates around its normal centre, is unduly prominent rather than approximated to the median line, and that the ilio-tibial band is not relaxed, as in fractures, should suffice to prevent mistakes.

When the *temporo-maxillary joint* is affected, the condyle of the jaw becomes larger than usual and somewhat flattened, whilst the eminentia articularis is partially absorbed and the glenoid cavity increased in size, so that there is a tendency for the condyle to slip forwards owing to the action of the external pterygoid muscles. If only one joint is affected, the bone is carried towards the sound side, but when both are involved the chin becomes prominent owing to a forward displacement of the whole bone. Pain and crepitus are experienced on opening the mouth, rendering mastication difficult, and even impracticable. If ordinary treatment fails to give relief, the affected condyle of the jaw should be excised.

For osteo-arthritis of the *Spine*, see Chapter XXIX.

Charcot's Disease (*Syn.:* **Tabetic Arthropathy**).

This disease bearing the name of the late Professor Charcot is a peculiar affection of joints met with in the course of locomotor ataxy. It is slightly more common in women than men, and is almost always an early manifestation of the disease, occurring usually between the lightning-like pains and the onset of the ataxic symptoms. The most typical form is lighted up by some slight injury—*e.g.*, a strain or sprain—and is characterized by a rapid painless distension of the joint with a light-coloured serum, which may also extend into the communicating bursæ; there is some amount of effusion into the surrounding cellular tissue, although without œdema. This distension may be so rapid that abnormal mobility or even dislocation may occur at the end of a few hours. The joints most frequently affected are the knee, hip, and shoulder; occasionally more than one articulation is involved. The course followed by the case varies; in some few instances the fluid is gradually absorbed and the joint returns to its normal size and shape, although usually somewhat weakened. Sometimes the attacks of distension recur, and after each the joint becomes more and more crippled. In others, however, and perhaps most frequently, the bones become eroded to a considerable extent, the ligaments stretched, and a weak, flail-like articulation remains, in which the ends of the bones are atrophied, and perhaps displaced (Fig. 195). In other instances new osseous formations occur here and there under the synovial membrane, especially in cases where there is much distension, so that on compressing the swelling between the hands a sensation is produced similar to that imparted by grasping a bag of bones. Occasionally, under these circumstances, the osseous masses become welded together, giving rise to large overgrowths, which lead subsequently to fixation of the joint. The disease sometimes runs a more chronic course, and then closely resembles osteo-arthritis, since there is but little effusion, whilst the ends of the bones become eroded, and osteophytes, perhaps of great size, form around the edges of the cartilages, leading to defective mobility and crepitus.

The **Diagnosis** of Charcot's disease from osteo-arthritis is, as a rule, readily made if one remembers the following points: Charcot's disease is usually characterized by a rapid onset, limitation to one joint, considerable effusion, absence of pain, atrophy of the ends of the bones, and a tendency to the production of a weak, flail-like joint, whilst the general signs of tabes are also observed. Osteo-arthritis, on the other hand, comes on slowly, often affects many joints, has but little effusion, is very painful, and is attended with overgrowth tending to produce ankyiosis. In the more chronic cases the distinguishing features are much less evident.

As to pathological anatomy, the changes observed are practically identical with those seen in osteo-arthritis, except that the erosion is more rapid, the effusion greater, and the tendency to the formation of osteophytes less marked.

The **Treatment** of Charcot's disease consists in keeping the limb at rest on a splint and applying elastic pressure. The effusion, when considerable, may be removed by an aspirator, but is very likely to re-collect. In the later stages, where the joint is entirely disorganized, some form of fixed apparatus may be applied to render the limb more useful, since no operative treatment can be undertaken.

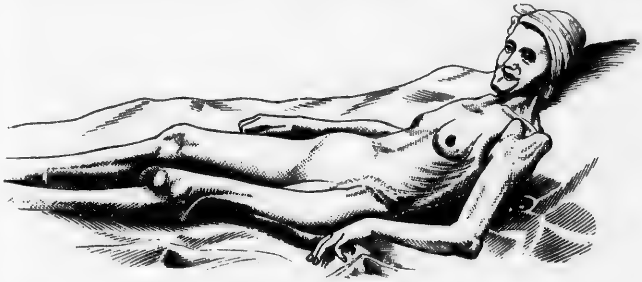

FIG. 195.—CHARCOT'S DISEASE OF LEFT KNEE AND SHOULDER.

The great atrophy of the ends of the bones, and the resulting dislocations, are clearly evident.

Somewhat similar in nature to Charcot's disease is the chronic arthritis met with in many conditions where the nervous supply to a limb is impaired as a result of central or peripheral disease of the nervous system. Thus, it may follow syringo-myelia, hemi- or para-plegia of cerebral or spinal origin, or may be secondary to a peripheral neuritis, due to either injury, syphilis, gout, diabetes, leprosy, etc. The terminal articulations of fingers or toes are those most often affected (acro-arthritis), although larger joints may be involved. They become swollen and painful, and after a time ankylosis ensues, but there is no tendency to suppuration.

Hæmophilic Diseases of Joints.

In hæmophilia (p. 233) any injury to a joint, such as a sprain or wrench, may lead to a copious effusion of blood into the articular cavity, which becomes suddenly swollen, distended, and evidently full of fluid. There is some pain on movement, the part becoming hot and tender, whilst when coagulation has taken place it is hard and firm. Total recovery may ensue, or the joint be left weak and liable to recurrences of hæmorrhage and inflammation. The effects on the articular surfaces are curious: the cartilages usually retain their normal colour, but become thin, worn, and rough, especially at the points of greatest pressure; fibrillar degeneration of the matrix may occur, and in some cases it has been found totally absent, being replaced by fibrous tissue. Ecchondroses subsequently developing into bone are found at the margins of the joint surfaces, the changes thus produced being somewhat like those of osteo-arthritis. The ligaments and synovial membranes may remain of a normal texture, or are slightly thickened, and usually of a russet-brown colour. Adhesions are often present, causing considerable impairment of mobility. The *treatment* consists in keeping the part at rest, and applying ice in the early stages; whilst, later on, friction, massage, and pressure may be employed. The surgeon must never attempt to aspirate the joint, even with a fine needle.

Loose Bodies in Joints.

Several varieties of loose bodies are met with in joints, which may be described as follows: (1) The so-called 'melon-seed bodies' consist of dense fibroid tissue derived from altered blood-clot, or more frequently from a fibrinous exudation in cases of very chronic tubercular disease. At first irregular in shape and laminated in texture, they are gradually transformed into round pellets by the movements of the articulation. Bursæ and tendon sheaths are much more frequently affected than joints. A considerable number of them are usually present, together with some glairy effusion, causing distension and a certain amount of creaking. We recently operated on a case in which the knee-joint was occupied by a number of rounded yellowish-white foreign bodies, several of which were nearly as large as walnuts; they were probably of hæmorrhagic origin. (2) Portions of the articular or interarticular cartilage may be broken off as a result of mechanical violence. They usually consist of a smooth rounded mass of articular cartilage enclosing a central bony nucleus. (3) They are sometimes derived from the development of cartilaginous nodules in the synovial fringes or villi, which may either remain adherent and become pedunculated, then occasionally wearing a bed for themselves in the articular surface, or may be totally detached. Such structures are usually lobulated and irregular in shape, and consist of calcified cartilage or bone, whilst a certain amount of normal cartilage is also present. It is not at all uncommon for this condition to be met with in osteo-arthritis, but sometimes the cartilaginous cells from which they are derived have persisted as a 'fœtal residue' owing to some modification in development. (4) Finally, portions of bone may become separated from their surroundings, and remain loose in the cavity. Thus, ecchondroses may be broken off in cases of osteo-arthritis, or portions of the articular surface detached by mechanical means, or even sclerosed areas isolated by a process of rarefying osteitis without suppuration, constituting what Paget originally described as 'quiet necrosis.'

Although cut off from all vascular supply, the growth of these loose bodies is said to continue, owing to the highly nutritious fluid which bathes their surface.

The **Symptoms** caused by this condition are produced by the loose body being occasionally caught between the articular surfaces, leading to a temporary locking of the joint, and with severe pain, owing to the stretching of the ligaments. The fixation is but momentary, since the foreign body is readily displaced, but an attack of subacute synovitis follows. When this has happened several times, there is a tendency for the ligaments to become relaxed, and for the joint to become somewhat loose and distended. Under such circumstances the patient may be able to feel the foreign body and to shift its position, and frequently the surgeon, owing to its ready mobility, is unable to detect the intruder as it slips away into the interior of the joint. From this point of view, the German term 'Gelenkmaus' (joint mouse), as applied to this affection, is most happy. The knee-joint is that most frequently affected, but the same condition occurs in the elbow and temporo-maxillary articulation.

The **Diagnosis** between a loose body and a displaced semilunar cartilage in the knee-joint is not always easy, since in both conditions painful locking of the joint is present. The fixation, however, is but momentary in the case of a loose body, but may persist until reduced in the latter, whilst a localized spot of tenderness may be detected corresponding to the site of the injury to the interarticular cartilage. Moreover, the history of the case is very different, since the dislocation of a semilunar cartilage is always primarily referred to some twist or sprain of the joint, whereas with a loose body no such traumatic influence need be present.

The **Treatment** consists in the removal of the foreign body. In former days this was done by means of various subcutaneous operations which it is unnecessary to describe here, since at the present time removal by the open method is practised. In the knee-joint a vertical incision should be made, about 2 inches in length, extending a little above and below the line of the articulation. It should be placed about 1 inch from the patella, on whichever side the loose cartilage presents most frequently, but preferably on the outer. If possible, it should always be fixed by the finger in one of the lateral pouches of the joint before making the incision. The capsule and synovial membrane are opened, the foreign body removed, and the cavity washed out, if thought desirable, with a sterilised saline solution. The wounds in the synovial membrane, capsule, and skin are then carefully sutured, and a drainage-tube inserted for forty-eight hours. The joint should be kept at rest subsequently for two or three weeks, and an elastic knee-cap worn for some time.

Neuralgic Joints.

In neurotic individuals, especially young women, a neuralgic condition of the joints is commonly met with, simulating disease of the articulation. On careful examination the pain is found to be superficial, not increased by jarring the articular surfaces together, and often not strictly confined to the joint. The movements are apparently limited, but if the attention of the individual is diverted, or anæsthesia induced, they are found to be perfectly free. There are no signs of effusion into the cavity, and no starting pains at night. Occasionally a similar condition is met with in men, where there is no suspicion of hysteria.

The *treatment* is constitutional and local. The former is directed towards improving the general health, and correcting any error in the uterine functions. The latter is best accomplished by the use of cold douches and electricity, although counter-irritation in the shape of blisters, or even the actual cautery, has an excellent moral effect.

Ankylosis.

By ankylosis is meant a condition of immobility, partial or complete, of a joint, resulting from some preceding inflammation of the articular structures.

The term is sometimes applied to a condition resulting from extra-articular lesions, and is then called *false* ankylosis. Such may be either fibrous or osseous, and is due to cicatricial contractions in the skin, shortening of muscles, or even to the development of bony tissue within them (*myositis ossificans*). *True* ankylosis, however, always involves the articular structures, and, again, may be either fibrous or bony.

Fibrous or incomplete ankylosis may result (*a*) from thickening and contraction of the ligaments, such as often occurs after gonorrhœal or rheumatic affections; (*b*) from the formation of cord- or band-like adhesions within the joint, as a result of acute synovitis; (*c*) from erosion of the cartilage and exposure of the bone, from which granulating surfaces spring up, leading to dense fibroid adhesions between them. Some amount of movement is possible in most of these cases.

Complete or osseous ankylosis arises from the union of either the whole or part of the opposing surfaces left by the destruction of the cartilage, the bond of union being subsequently ossified (Fig. 196); it may also be due to the interlocking and fusion of osteophytes, formed at the margin of the bone in osteo-arthritis or Charcot's disease.

The **Causes** of ankylosis are very variable, but may be arranged as follows:

1. Injury to the articular surfaces, as in fractures which run into a joint.

2. Primary inflammatory lesions of joints, involving the formation of fibrous adhesions or the contraction of ligaments, as in synovitis, whether traumatic, rheumatic, gouty, gonorrhœal, etc., and the early stages of acute or tubercular arthritis.

3. Destruction of bones, associated or not with articular diseases, as in Pott's disease of the spine, and the later stages of acute or tubercular arthritis.

4. Nervous affections are occasionally the primary cause of ankylosis, by leading to a chronic form of arthritis. The lesions may be central, as in spina bifida, tabes and syringo-myelia; or peripheral, as in neuritis, Raynaud's disease, diabetes, leprosy, or division of nerves.

5. Long-continued abnormal pressure of contiguous bones may result in ankylosis, as in lateral curvature or osteo-arthritis of the spine. In the latter affection the immobility may be due either to ossification of ligaments or the interlocking of osteophytes.

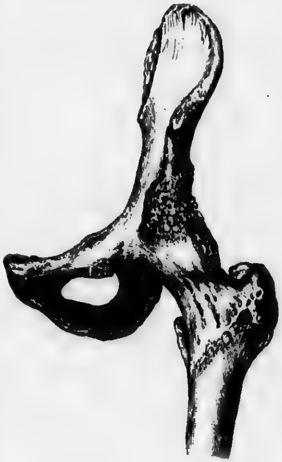

FIG. 196.—ANKYLOSIS OF HIP-JOINT IN GOOD POSITION AFTER EARLY HIP DISEASE. (HOWARD MARSH.)

The position in which ankylosis occurs, and the *effects* thus produced differ according to the joint affected.

In the *shoulder* there is but little displacement, and the existence of immobility is of comparatively little importance, owing to the free movements of the scapula and clavicle. The *elbow-joint* is very commonly ankylosed on account of its exposed position, and the frequency of fracture-dislocations in its neighbourhood. The formation of callus, and the adhesions likely to form within the joint in these cases, readily explain its frequency. The most favourable position for ankylosis to occur in is when the arm is flexed to a little more than a right angle, with the hand midway between pronation and supination. By this means access to the mouth is possible, and the patient can use his hand for feeding purposes. The *wrist* is most commonly fixed as a result of gonorrhœal or rheumatic synovitis. In the *hip-joint* (Fig. 196) much depends upon the treatment as to whether the ankylosis takes place in a good or bad position. In neglected cases the thigh may be fixed in a position of adduction and internal rotation, crossing in front of the other leg. A few cases are on record in which a *scissor-like deformity* has resulted from inflammation of both hip-joints: progression is accomplished with difficulty, the body twisting at each step, and crutches are often needed. In the *knee-joint* ankylosis in an absolutely straight position of the limb should not be aimed at, since slight flexion renders the leg more useful both in walking, mounting stairs, and sitting down. In the *ankle-joint*, unless the foot is at right angles to the leg, considerable trouble may arise from the immobility of the joint.

Treatment.—*Fibrous* ankylosis may be treated by forcible, though judicious, manipulation of the limb under an anæsthetic, thereby rupturing adhesions , the limb is kept at rest for a few days, and then massage and passive movements are employed. If massive adhesions are present, but little good as regards mobility results from such treatment, since, even if ruptured by the manipulations, they are almost certain to reunite; in tubercular cases it is unwise to attempt this for fear of restarting or diffusing the disease. For *osseous* ankylosis various operative measures may be employed, with a view either to merely correct the deformity, or in other cases to restore movement to the part. At the *shoulder, wrist, and ankle* nothing need be undertaken unless obvious and troublesome deformity is present. At the *elbow* excision may be beneficially employed, and with every prospect of gaining a moveable joint. If, however, ankylosis is present in a child, the operation should be deferred until growth has come to an end. Ankylosis of the *knee* in a false position needs osteotomy, or the resection of a wedge-shaped portion of bone, in order to obtain a rigid and useful limb.

Ankylosis of the *hip-joint* in a bad position is best treated by dividing the neck or the upper part of the shaft of the femur. Several operations have been devised for this purpose: 1. Adams' subcutaneous osteotomy of the neck of the bone consists in passing a sharp-pointed bistoury down to the anterior surface of the cervix femoris, from a point midway between the trochanter and the anterior superior spine of the ilium. A track is thus made, allowing the introduction of an Adams' osteotomy saw, by means of which the neck of the femur is divided subcutaneously. The limb is put up in a straight position, and the bone allowed to reunite. 2. The same result may be obtained by an open method, making the same incision as in the anterior operation for excising the joint (p. 603). 3. Sayre has attempted to form a moveable joint by dividing the femur by a chain saw between the greater and lesser trochanters, and removing a segment of bone. It is very unlikely to prove successful. 4. Gant has suggested division below the lesser trochanter. This may be accomplished by cutting down on the bone from the outer side and chiselling it across.

As to the operation to select in any particular case, the surgeon's choice must be guided by the condition of affairs present. Sometimes the neck of the femur is stunted, and has practically disappeared; in other cases it is much thickened, and forms a large bony mass passing from the trochanter to the ilium, and possibly containing encapsuled foci of tubercular material. In both these conditions subtrochanteric osteotomy must be undertaken, and it is not unusual to find that the adductor muscles are contracted, and will require section before the limb can be satisfactorily straightened. Division of the cervix can only be recommended when that structure is of normal length and size.

Hip-joint Disease.

Although the term 'hip-joint disease' is usually applied to a tubercular arthritis, it is not the only affection involving this articulation. Simple synovitis occurs in the course of rheumatic, gonorrhœal, or pyæmic affections. Acute arthritis is also met with secondary to an acute infective osteomyelitis of the upper end of the femur, and is evidenced by all the ordinary signs of that affection, separation and necrosis of the upper epiphysis being a frequent result. Osteo-arthritis is not uncommon (p. 583), whilst Charcot's disease may also occur; but none of these call for special mention here.

Tubercular Disease of the Hip (*syn.*: **Morbus Coxæ, Tubercular Coxitis, Coxalgia**) differs in no respect from the same disease as it affects other joints, and hence no detailed notice of the pathological anatomy need be entered into. Suffice it to say that it may originate in the synovial membrane or bone, and in the latter commences most commonly on the shaft side of the epiphyseal cartilage of the caput femoris (Fig. 197), or beneath the articular cartilage. Very rarely the disease becomes circumscribed in the neck of the bone, forming a chronic abscess, a condition the diagnosis of which is exceedingly difficult. The pus may in fortunate cases be reached and evacuated by trephining the neck of the bone through the trochanter major. More usually the disease spreads to the under side of the neck, and thus involves the synovial membrane, which passes into a state of pulpy degeneration. The substance of the epiphysis is also invaded, and caries of the head is thereby produced, together with necrosis or ulceration of the cartilage. The acetabulum undergoes similar changes; from the contact and backward pressure of the diseased head the posterior acetabular margin is absorbed and the cavity extended, whilst at the same time a new rim of bone forms beneath the adjacent periosteum at a slightly higher level, thus giving rise to what is known as a 'travelling acetabulum.' In this the cavity is increased both in size and depth, travelling backwards and upwards with the head of the bone towards the dorsum ilii. Other factors assisting in the displacement of the head of the bone are: the tonic action of the muscles, keeping the limb in a position of flexion, adduction, and inversion, thereby causing a considerable portion of the head to project out of the cavity; and the early softening and destruction of the posterior ligaments, which are much thinner than those in front of the joint. Occasionally a mass of protuberant granulations sprouts up from the centre of the cavity, and may also assist in this process. When the acetabulum becomes perforated, a tubercular abscess forms within the pelvis. The adjacent pelvic bones may either become thickened by the deposit of osteophytes, or carious; if sepsis is present, necrosis may also supervene.

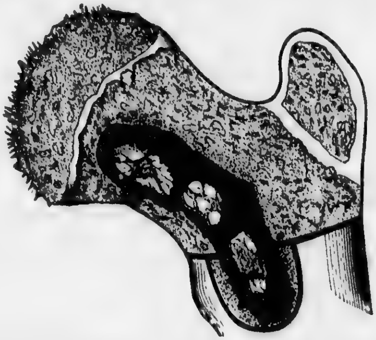

FIG. 197.—TUBERCULAR DISEASE OF THE HEAD AND NECK OF THE FEMUR, SHOWING SEQUESTRA IN AN ABSCESS CAVITY, AND COMMUNICATION ON THE UNDER SIDE OF THE NECK WITH THE JOINT. (TILLMANNS.)

The cartilage has been entirely removed from the articular surface, and the continuous black line indicates the amount of bone which it would be necessary to remove.

Clinical History.—The patient, usually a child, is observed to limp, and may complain of pain either in the hip or knee, the latter being due to the fact that both joints are supplied by the same nerves, viz., the anterior crural, sciatic, and obturator trunks. There may be some history of injury, but not necessarily. On examining the limb in the *early stage*, it is usually found to be *apparently lengthened*, whilst the thigh is slightly wasted. The nates are flattened, and the gluteal fold lost, conditions partly due to atrophy of the muscles, partly to the flexion of the limb. The joint is more or less rigid, and pain is produced on attempts to move it, or on jarring the limb, as by striking the heel or trochanter. The position assumed in this early stage is one of slight and increasing flexion, abduction, and eversion (Fig. 198, A), the reason for this being that thereby the ligaments are most relaxed, and the capacity of the joint is at its greatest. The latter point has been demonstrated in the healthy cadaver by inserting the nozzle of a syringe into the joint through the acetabulum, and forcibly injecting fluid, when this position is at once assumed. The flexion and abduction, however, are not always evident, since the flexion can be masked by lordosis of the spine (Fig. 199), and the abduction by the pelvis being tilted down on the affected side, producing thereby apparent lengthening of the diseased limb and lateral curvature of the spine, with its lumbar convexity towards the affected side (Fig. 198, B). The sound limb being brought into a position of adduction, the parallelism of the limbs is maintained. The flexion can be demonstrated by any method which obliterates the lumbar curve of the spine, as by fully bending up the sound limb on the abdomen, the affected thigh rising at once from the bed and forming an angle which indicates the amount of flexion. The abduction is demonstrated by laying a rod across the two anterior superior spines, and placing another at right angles to its centre. This will not correspond with the line of the body, or of the limb, but makes an angle with it. The eversion cannot be masked. The rigidity is easily demonstrable in that all movements of the hip-joint are greatly limited; thus if an attempt is made to bend the affected limb on the abdomen, the corresponding side of the pelvis will be drawn up with it from the bed.

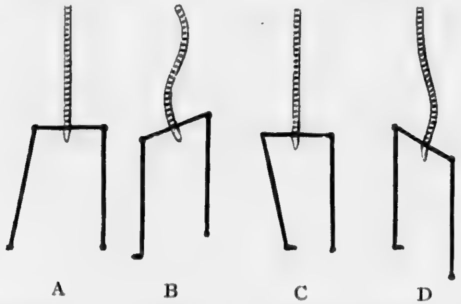

FIG. 198.—DIAGRAM TO ILLUSTRATE THE POSITIONS ASSUMED BY THE LIMB IN THE EARLY AND LATE STAGES OF HIP DISEASE.

A represents the position of abduction taken by the right limb in the early stage of hip disease, and B, Nature's method of masking this by tilting the pelvis down on the affected side, whilst the other limb is adducted; the effect of this on the spine, in causing a lateral deflection, is also indicated. C shows the same thing in the later stage, when adduction is present, and the pelvis is tilted upwards on the affected side, thus producing apparent shortening (D).

As the disease progresses, and the bones become more extensively affected, the pain increases, with nocturnal startings, whilst abscesses form, and a certain amount of fever and constitutional disturbance is caused thereby. The position of the limb also changes; for although the flexion is maintained and even increased, adduction and inversion are now associated with it. The pelvis is tilted up on the affected side (Fig. 198, C and D), causing *apparent shortening*, lateral curvature with a lumbar convexity to the sound side, and abduction of the healthy limb. No satisfactory cause of this position is given, but it is usually stated to be due to the yielding of the posterior and outer part to the capsule, together with infiltration and weakening of the small external rotator muscles, allowing the adductors and internal rotators unopposed play. When an abscess has formed, the most usual situation for it to point is a little in front of and internal to the great trochanter, close to the insertion of the tensor fasciæ femoris. It may reach that spot either from an opening in the anterior part of the capsule, coming thus along the line of least resistance to the surface, or it may burrow from the posterior portion of the capsule along the rotator muscles and superior gluteal nerve. Less frequently abscesses may pass directly backwards to open in the gluteal region, or forwards

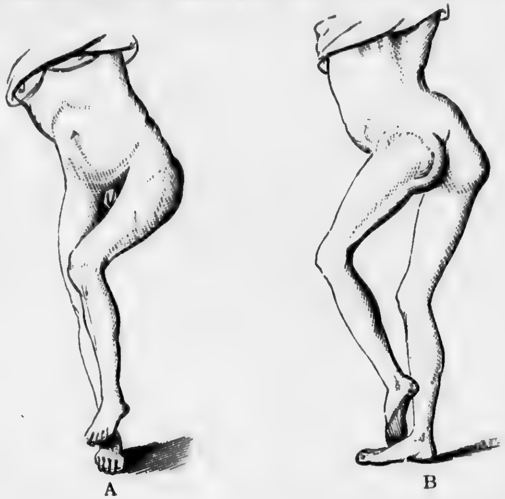

FIG. 199.—POSITION OF THE LIMB IN THE LATER STAGES OF HIP DISEASE.

A shows more especially the adduction and inversion; B, the flexion and compensatory lordosis.

along the pubo-femoral ligament, pointing on the inner side of the femoral vessels below Poupart's ligament. As a rare complication, the tubercular process may extend to the bursa under the psoas tendon, which usually communicates with the joint, leading to the formation of an abscess in the lower part of Scarpa's triangle, and in a case recently under treatment a typical psoas abscess resulted from an extension upwards within the sheath of the muscle of a tubercular infection of this bursa. An intrapelvic abscess following perforation or disease of the acetabulum may either burrow upwards, and come to the surface to the inner side of the vessels above Poupart's ligament; or it may gravitate downwards, and burst in the ischio-rectal fossa, close to the tuber ischii.

The final stage of the disease is one of *real shortening* (Fig. 199), due to erosion of the head of the bone, and its displacement backwards upon the dorsum ilii. The position assumed is one of increased flexion, adduction, and inversion; whilst if septic sinuses persist, hectic fever and amyloid changes in the viscera are likely to follow.

At any stage cure by ankylosis may be obtained; but unless the abnormal position has been corrected by extension, considerable deformity may ensue.

The **Diagnosis** of hip disease appears to be a matter of considerable difficulty to some, if we may argue from the mistakes which so commonly occur. The pain in the knee present in the early stages leads to its frequently being mistaken for disease of that articulation. A very slight amount of care in the examination should prevent such an error. From disease of *the opposite hip*, it is recognised by the relative mobility of the thigh on the two sides. The diagnosis from *sacro-iliac* disease is given at p. 598. It may also be confounded with *spinal mischief*, if a psoas abscess points at any of the ordinary situations in which sinuses form in connection with the hip-joint. The presence of spinal deformity and the ability to perform the test movement for hip disease should readily enable the surgeon to make a correct diagnosis, but it must not be forgotten that the two conditions not unfrequently co-exist. If the limb can be put into what is known as the tailor's position—that is, flexion to a right angle with marked abduction and eversion—one may be certain that hip disease is not present.

An *encapsuled abscess in the neck of the femur* is a condition which it is very difficult to distinguish from true hip disease. The usual pain may be complained of, and it may be increased by pressure over the neck, or by jarring the trochanter; but if the limb is manipulated gently, it may be proved that the movements of the joint are not really impaired.

The **Prognosis** of hip disease, if the condition is properly treated, is by no means unfavourable. Of course, the patient is liable to develop acute tuberculosis or tubercular disease elsewhere; or, if abscesses are allowed to become septic, serious complications—such as pyæmia, sapræmia, hectic and amyloid disease—may ensue. Apart from these, however, no serious consequences affecting life need be feared, although the usefulness of the limb may be seriously crippled from shortening or ankylosis, especially if it occur in a defective position.

The **Treatment** of hip disease must be conducted along the same lines as for tubercular disease elsewhere. In the *early stages* the limb is kept at rest by the application of a Liston's long splint, or it may be placed between sandbags, and a weight and pulley attached. By this means not only is rest assured, but deformity is prevented. If the amount of flexion is but slight, the limb may be allowed to rest on the bed in the horizontal posture; this will possibly lead to some compensatory lordosis, but as the muscular spasm relaxes, the curvature of the spine disappears. When, however, a considerable degree of flexion is present, extension must be made along the axis of the flexed limb, which is supported on pillows. It will be found that after a few days the flexion diminishes, and the limb will then gradually assume the horizontal position. Should this precaution not be adopted, the extension merely leads to lordosis, and the pain from intra-articular tension is increased thereby. The general health of the patient must at the same time be attended to, and cod-liver oil and syrup of the iodide of iron may be administered with benefit. When the more urgent symptoms have disappeared, a Thomas's hip-splint should be applied, so as to enable the patient to get about (Fig. 200). This consists of a flat rod of malleable iron, about an inch and a half wide, extending from the axilla to below the knee; it is shaped so as to fit the varying curves of the body, and cross-pieces embrace the trunk at the level of the nipples, as also the thigh and the calf; it is firmly bandaged to the body and limb. A patten is placed under the boot of the sound leg, and the patient allowed to get about on crutches. This apparatus should be worn for six months after all signs of active disease have disappeared. It may also be employed in the earlier and more painful stages if it is at first bent so as to accommodate itself to the flexed

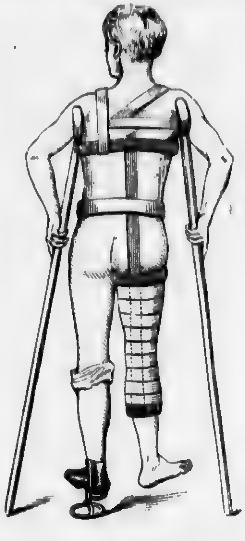

FIG. 200.—THOMAS'S HIP-SPLINT APPLIED.

position of the limb; as the effect of the rest becomes evident in the diminution of muscular spasm, the splint can gradually be straightened out, so that at length the limb is fully extended.

When abscesses form, they may be opened antiseptically and drained, or tapped and injected with iodoform, the former precautions as to rest and constitutional treatment being still maintained; but frequently more extensive operative treatment—such as *excision* of the head by the *anterior* method (p. 603)—is undertaken in the early stages so as to cut short the disease, especially when prolonged treatment is undesirable, as amongst the poor, or when the general health and constitutional powers are defective.

In the *later stages*, and especially where sinuses have formed in the gluteal region or behind the trochanter, *excision* by the *posterior* method (p. 603) may be preferable; this is an easy matter when the head is eroded and displaced, but may be one of some difficulty if the head is still in the acetabulum. The sinuses should, if possible, be included in the incision, but under any circumstances must be opened up and scraped. When the acetabulum is extensively implicated, the disease can only be satisfactorily dealt with by removing the head of the bone, and the posterior method affords the best means of subsequent drainage; of course this presumes that the general condition of the patient has not been seriously undermined, and that there is a good prospect of gaining a useful limb. Otherwise *amputation* through the hip-joint is required, especially when the mischief has extended into the pelvis, or when, after excision, a weak, flail-like limb results or osteo-myelitis supervenes. It is also needed when after excision sinuses persist and lead down into the acetabular cavity, from which there is a plentiful secretion of pus, and over the entrance to which the upper end of the femur is drawn, thereby obstructing the evacuation of the discharge, and rendering dressing both difficult and painful. The operation often gives most excellent results, the patient's condition rapidly improving. Removal by the anterior racket method is perhaps the most convenient.

Disease of the Sacro-iliac Joint.

Tubercular disease of this joint is most commonly met with in adults, and is rarely seen in children. It may commence in the synovial membrane, but is most frequently the result of mischief starting in the pelvic bones, especially the ilium. The **Pathological Anatomy** calls for no reference here, inasmuch as it follows the ordinary course of tubercular disease.

The **Clinical Signs** consist of pain and a sense of weakness in the lower part of the back, increased by standing, walking, or any actions—such as coughing, sneezing, and the like—which call the flat abdominal muscles into sudden action and drag on the ilium. It is of a very unpleasant character, a sensation as if the pelvis were coming to pieces being experienced by the unfortunate individual. Owing to the fact that the lumbo-sacral cord passes in front of the articulation, pain is often referred to the gluteal region. Movements of the leg cause pain if the pelvis is not supported, but can be freely performed if the pelvis is steadied. Compression of the innominate bones, or forcible separation of them, is the means of most effectually demonstrating the existence and situation of the pain. The patient is unable to stand or to put any weight on the affected limb, and hence limps during walking, allowing his body to lean forwards, and making use of a stick. There is apparent lengthening on the affected side, but on measurement from the anterior superior spine to the internal malleolus the limb is found to be of the same length as its fellow. This appearance is due to the fact that the whole innominate bone is tilted downwards and forwards, so that the anterior superior spine is at a lower level and more prominent than that on the opposite side. The region of the synchondrosis may be swollen, puffy, and tender; whilst after a time abscesses form, which may point either immediately over the articulation, or may burrow upwards into the lumbar region, or forwards into the groin, or downwards into the pelvis opening in the ischio-rectal fossa. The latter is a most serious complication, since it necessarily introduces the septic element.

The **Diagnosis** needs to be made from sciatica, hip disease, and spinal disease. *Sciatica* is known by the character of the pain, which shoots down the back of the thigh in the course of the great sciatic nerve, which may be distinctly tender on pressure. There is no apparent elongation of the limb, and compression of the pelvic crests is painless. From affections of the *hip-joint*, sacro-iliac disease is recognised by the fact that, if the pelvis is supported, the thigh may be moved in all directions without great discomfort; whilst compression of the pelvis in hip disease causes no pain. Moreover, in the advanced stages of hip disease, there is apparent or real shortening, a condition never noticed in the sacro-iliac affection. From *spinal disease*, the diagnosis should not be difficult if a careful physical examination of the spine and pelvis is made.

The **Prognosis** of sacro-iliac disease, though usually stated to be unfavourable, is not necessarily so if asepsis is maintained; it is the admission of the septic element that constitutes the main danger.

Treatment in the early stages consists in absolute rest, with the application of a pelvic support, and attention to the general health, combined possibly with local counter-irritation. When abscesses form, they should be freely opened, and if diseased bone can be felt with a probe, it should be scraped or cut away, and the parts purified with pure carbolic acid. Occasionally it is necessary to remove the posterior part of the iliac crest in the neighbourhood of the posterior superior spine in order to gain access to the diseased area; this may be accomplished by the chisel or trephine through a vertical incision, and we have had a number of excellent results demonstrating the value of this proceeding.

Excision of Joints.

The excision of joints is a proceeding which, though formerly undertaken in a few isolated instances for compound fractures and dislocations, has only during the past fifty years been established on a scientific basis, or utilized to any great extent. The late Sir William Fergusson was one of the chief pioneers in this branch of operative surgery, and to his skill and insight we owe much of what has thus been gained. Since the introduction of antisepsis, however, the operations have been still further elaborated, and excision is now undertaken for many conditions that formerly would not have been so treated. The chief articular lesions for which excision, partial or complete, is now recommended are as follow: 1. For compound dislocations or fracture dislocations; 2. For various forms of simple or comminuted fracture in the neighbourhood of joints where ankylosis is likely to follow, and either interfere seriously with the utility of the joint or fix it in a bad position; the shoulder and elbow are the joints most frequently dealt with in this way; 3. For some forms of congenital or old-standing dislocation which cannot be otherwise dealt with; 4. In the later stages of acute arthritis, where the ends of the bones are carious, the joint disorganized, and chronic suppuration is present; 5. In tubercular arthritis, where palliative treatment has failed to cut short the disease, or where disorganization of the joint has occurred with erosion of the ends of the bones; 6. For ankylosis of certain joints, consecutive to arthritis, either acute, tubercular, or syphilitic, especially if in a bad position; 7. For osteo-arthritis in special regions.

The results to be attained necessarily vary in the different joints, and according to the particular causes. Sometimes ankylosis in a good position is all that can be expected, in others a freely moveable pseudarthrosis; in some cases the removal of certain diseased tissues is the primary object of the operation, whilst in others no disease is present. All these varying conditions must be taken into consideration in determining the nature of any excision, as by them the exact steps of the procedure are modified.

Professor Ollier of Lyons deserves special and honourable mention in this connection, in that he has emphasized and established the benefits to be derived from subperiosteal resections in certain cases. Necessarily, every excision must lead to considerable interference with the peri-articular structures; muscles and tendons have to be detached from their insertions, and portions of the bones removed. If, however, the periosteum is raised, together with the attached muscles and tendons, prior to sawing or cutting the bones away, a more satisfactory reproduction of the articular structures follows, and the movements of the joint suffer less interference than if one cuts away the periosteal envelope with the bone. Of course, where the periosteum is invaded with tubercular deposit, this should not be attempted, whilst in some joints—such as the elbow—there is no advantage to be derived from it, since there is always a tendency to too great a formation of bone, and this would possibly be exaggerated by a subperiosteal resection. It is rather in the operations undertaken for traumatic lesions that this plan is to be recommended.

In a small text-book like this, it is impossible to deal with all the modifications that have been suggested for the excision of the different joints and bones, and therefore we shall limit ourselves to a description of the methods most commonly adopted, and must refer students to special works on Operative Surgery for further details.

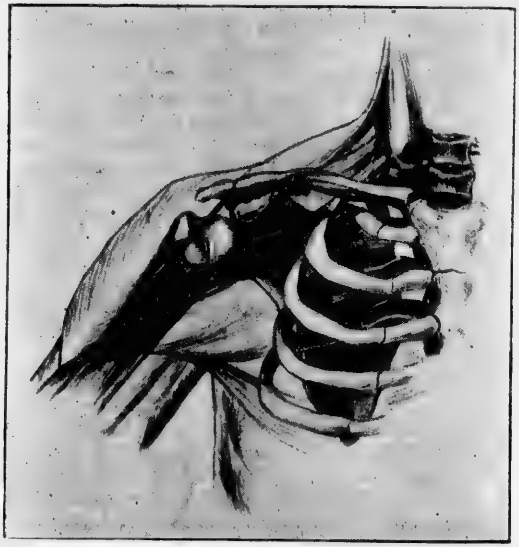

FIG. 201.—INCISION FOR EXCISION OF SHOULDER.

Shoulder-joint.—Excision of the shoulder-joint may be needed for tubercular disease, the later stages of acute arthritis, occasionally for osteo-arthritis if the disease is limited to this articulation, for compound or comminuted fractures, and possibly for simple fractures of the anatomical neck when associated with dislocation of the small detached head of the bone. In old unreduced dislocations where passive movement is impracticable, and there is little hope of improvement, excision may give excellent results.

Operation.—The patient lies on the back, the shoulder projecting somewhat over the edge of the table, and with a sandbag beneath the scapula to steady it. The arm being slightly rotated inwards, an incision is made from a point midway between the coracoid process and the acromion, extending downwards and outwards for 3 or 4 inches through the fibres of the deltoid muscle, and reaching to the bone (Fig. 201). It is better to incise the deltoid than to pass between it and the pectoralis major, the cephalic vein and accompanying artery being thus uninjured. The wound is thoroughly opened up by means of retractors, and the bicipital groove looked for; an incision is made along the outer border of this, and the long tendon of the biceps, if still present, turned out, and held to the inner side by a blunt hook. A twig of the anterior circumflex artery will here be divided, and need a ligature. The arm is now thoroughly everted, and the tendon of the subscapularis and the anterior part of the capsule, with which it is incorporated, freely divided; where practicable, the attachments of the muscle to the bone should be separated subperiosteally, a proceeding presenting no difficulty where inflammation has previously existed. The arm is now inverted and held downwards by the side of the table, so as to bring the great tuberosity into view; the muscles attached to this process are dealt with in a similar way, and the upper part of the capsule freely opened. The head of the bone can be readily protruded into the wound, and removed by the saw. It will often suffice to apply the saw obliquely through the substance of the tuberosity; this is to be preferred to removal of the whole tuberosity by a horizontal incision at a lower level. The synovial membrane and glenoid cavity are dealt with as circumstances may dictate, and it is often advisable to make a counter-opening through the posterior axillary fold for the insertion of a drainage-tube; the anterior wound can then be entirely closed. In applying the dressing, care must be taken to put a good pad in the axilla, so as to keep the arm from being drawn forcibly inwards by the muscles attached to the bicipital groove. There is no need to commence passive movements before the end of the first week. Fibrous union usually results, and the movements of the shoulder are generally very good.

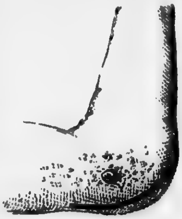
FIG. 202.—INCISION FOR EXCISION OF ELBOW.

Excision of the Elbow may be required for simple or compound fracture-dislocation, or for subsequent ankylosis—especially if the limb is in a bad position—for tubercular arthritis, and possibly in the later stages of acute arthritis. The best plan of operating is as follows: A single longitudinal incision, 5 inches in length (Fig. 202), is made in the middle line of the posterior aspect of the joint, extending for equal distances above and below the tip of the olecranon, and a little to the inner side. The limb may be held across the patient's body, the surgeon standing on the sound side; or some prefer to stand on the affected side. The incision extends through the substance of the triceps down to the bone. The tendon of the triceps is then separated from its attachments to the olecranon, care being taken to maintain some continuity of the muscle with the deep fascia of the forearm. The origin of the flexor carpi ulnaris is also divided, and the hollow between the olecranon and the internal condyle cleared, the knife being kept close to the bone, and the soft parts retracted by a vigorous use of the thumb-nail. By this means the ulnar nerve will escape injury, and, indeed, is often not seen at all. The internal lateral ligament should be divided, and part of the common origin of the flexors. The outer half of the joint is then dealt with in a similar way, the anconeus being divided close to its insertion to the ulna, the continuity of the triceps with the deep fascia covering it being also maintained. The origin of the extensor muscles is separated from the bone, and the external lateral ligament severed. The joint can now be freely opened by dividing any of the fibres of the posterior ligament which remain intact. The ends of the bones thus freed are protruded from the wound, and the olecranon, together with the upper articular surface of the coronoid process and the head of the radius, are sawn off, care being taken to draw aside and protect the soft parts by retractors, especially those covering the ulnar nerve; the lower end of the humerus is now thoroughly cleared, and the articular surface removed, whilst the synovial membrane can be dealt with as may be necessary. Even if the head of the radius is free from disease, nothing is gained by leaving it intact, since ankylosis is very likely to follow unless plenty of bone is removed. For a similar reason subperiosteal resection is needless, and, indeed, is an undesirable refinement. The wound is carefully sutured, and a drainage-tube inserted for a few hours. The limb is kept on a hinged angular splint for a week, by which time union of the external wound should be complete, but the position should be altered each day. After a week, the splint may be dispensed with, and the limb kept at rest on a pillow, free passive movement, both angular and rotary, being daily practised. Considerable attention is needed in order to obtain a good result, but in a successful case every movement of the joint may be perfectly restored. As a rule, the lower end of the humerus develops two lateral bony processes, like malleoli, within the grasp of which the upper rounded ends of the radius and ulna are able to move.

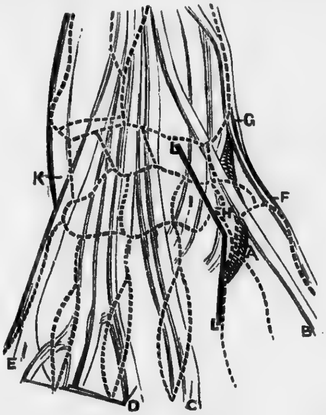

FIG. 203.—EXCISION OF THE WRIST. (LISTER.)

A, Radial artery; B, extensor secundi internodii pollicis; C, ext. indicis; D, ext. communis digitorum; E, ext. minimi digiti; F, ext. primi internodii pollicis; G, ext. ossis metacarpi pollicis; H, ext. carpi radialis longior; I, ext. carpi radialis brevior; K, ext. carpi ulnaris; L,L, line of radial incision.

The **Wrist-joint** is only excised for extensive tubercular disease, when abscesses and sinuses are present. Ankylosis of the articulation, though a troublesome condition, is not sufficiently so to call for such treatment. The best method to employ is that known as Lister's operation, a somewhat complicated proceeding, but which in suitable cases gives excellent results. Prior to operating the fingers are well bent, so as to break down any adhesions which may be present. Two incisions are made, one on the radial side of the dorsum, and the other on the inner or ulnar aspect of the wrist. The dorsal incision is angular (Fig. 203, L, L), commencing at a point on the back of the radius between the tendons of the extensor secundi internodii pollicis and the extensor communis digitorum; it is at first parallel to the former tendon, and on its ulnar side, till it reaches the base of the second metacarpal bone, when its direction is changed, and it courses downwards along that bone for an inch or two. It should extend down to the bones, and in doing so the tendons of the extensor carpi radialis longior and brevior (H and I) are divided as close to their attachments as possible. The tendinous structures are then stripped off the back of the dorsum on either side of the incision, and on the outer side a pair of cutting pliers is insinuated so as to detach the trapezium from the rest of the carpus. The synovial sheaths of these tendons should, if possible, not be opened. The hand is then rolled over, and the ulnar incision made well on the inner side of the limb, extending for at least 3 inches between the extensor and flexor carpi ulnaris tendons. The separation of the extensor tendons from the back of the carpus is now completed, but the attachment of the extensor carpi ulnaris (K) must be divided. The tissues on the palmar aspect of the joint are now detached, the pisiform being severed from the rest of the carpus, and where possible left, and the hook of the unciform clipped off with cutting pliers. The carpus is now free front and back, and the bones are either removed piecemeal or taken away *en bloc* by inserting a pair of cutting pliers above and below, and dividing their upper and lower connections. More usually the carpal bones are picked out in fragments. Attention is now directed to the lower ends of the radius and ulna, and to the articular ends of the metacarpal bones, all the cartilage and the intervening synovial tissue being cleared away. Finally, the remaining fragments of the carpus are dealt with as the case may require. The radial incision may often be entirely closed, whilst a drainage-tube is inserted through the ulnar wound. The hand is then placed on a special splint, with a thick convex cork support for the palm, which keeps the wrist slightly extended, and a short lateral projection upon which the thumb can rest. The fingers must be thoroughly flexed and extended daily, beginning on the second or third day, but the wrist should be kept at rest until it is quite firm. There is a much greater tendency to a flail-like joint than to undue fixity, owing to the amount of bone removed, and the necessary divisions of all the extensors of the carpus; if such occurs, a leather support must be worn, either as a temporary or permanent appliance.

The **Hip-joint** is rarely excised for conditions other than tubercular disease, and even for this it is performed much less frequently than formerly. There are two chief methods of operating:

1. Excision by the *anterior method* is carried out as follows: The incision (Fig. 83, D) extends from immediately below the anterior superior spine vertically downwards for 3 or 4 inches. It passes between the tensor fasciæ femoris and sartorius muscles superficially, and between the gluteus minimus and rectus deeply, a small arterial twig from the external circumflex being divided at this stage. The neck of the bone and capsule of the joint are exposed by this means, and the latter is freely incised along its attachment to the anterior intertrochanteric line, so as to allow of the admission of the finger, whereby the joint can be fully explored. The neck of the bone is cut through *in situ* by means of an Adams' osteotomy saw, the incision through the bone being placed obliquely downwards and inwards. The head of the bone is now either prised out of the acetabulum by an elevator, or grasped by lion forceps and twisted out, a matter easily accomplished where the articular structures are diseased, but a proceeding of much difficulty in a normal joint or on the cadaver. As much of the infected synovial membrane as possible is clipped away with scissors, and the acetabulum scraped, if necessary. The external wound is either closed, with the exception of an opening for a drainage tube, or plugged with gauze soaked in iodoform emulsion. There may be comparatively little shortening of the limb as the result of this proceeding, but the movements are considerably limited.

2. Excision by the *posterior method*, as we have already said, is usually undertaken in the later stages of the disease. Any sinuses which exist posteriorly may be utilized, but if the skin is unbroken, an incision known as Langenbeck's may be employed (Fig. 204). The patient lies on the sound limb, whilst the affected thigh is flexed. The incision is made in the line of the femur, extending 2 inches above the top of the great trochanter, and about

3 inches below it. It is carried at once down to the bone, and the muscles attached to the summit and posterior border of the great trochanter freely divided, as close to the bone as possible. The capsule is opened to a sufficient extent to allow of the exploration of the joint by the finger. If the disease is very extensive, the femur is now chiselled across, immediately below the great trochanter, but, if possible, above the lesser. The upper end of the bone is grasped by lion forceps, and twisted out of the acetabulum, after division of the remaining structures, which are attached chiefly along its anterior border. The ligamentum teres has almost always been previously destroyed, and hence this stage of the operation is not especially difficult. The synovial membrane and acetabulum are easily reached, and the diseased portions removed. In favourable cases a drainage-tube may be inserted, and the wound closed, but not uncommonly it is wiser to partially stuff it with gauze infiltrated with iodoform, and allow it to heal by granulation. Slight extension of the limb should be subsequently made, so as to prevent undue shortening from the traction of the long thigh muscles. The leg should be placed between sandbags, or a Liston's long splint applied. Fibrous ankylosis, with a certain limited amount of movement, is the usual result.

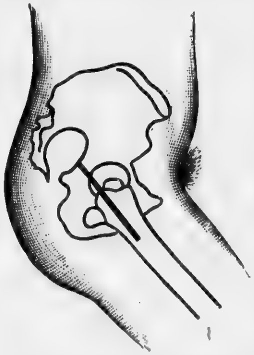

FIG. 204.—LANGENBECK'S INCISION FOR EXCISION OF THE HIP FROM BEHIND. (TILLMANNS.)

It is not always necessary to include the trochanter in this operation. If it is probable that the disease is limited to the head of the bone, it alone should be removed with as little disturbance as possible to the muscles passing to the trochanter. If such can be effected, the subsequent mobility and usefulness of the limb are considerably increased.

The advantages claimed for the anterior method are: that it is a less severe operation that fewer muscles and tendons are interfered with, that no vessels of importance are divided, and that only the head of the bone is excised. The objections to it are: that the drainage provided is very unsatisfactory, that the trochanter cannot be readily dealt with, whilst it is also difficult to remove all the synovial membrane.

The great advantages of the posterior operation are that, in spite of a free division of the muscular and tendinous attachments, excellent drainage is provided, and both trochanter and acetabulum are readily accessible. On the whole, the anterior method should be employed in the early stages of the disease, the posterior in the later. The situation of abscesses or sinuses may, however, determine the choice of the surgeon.

The **Knee-joint** is excised for tubercular disease, osteo-arthritis, or deformity due to osseous or fibrous ankylosis in a bad position. A horseshoe-shaped incision is made extending from the back of one condyle to the other, reaching downwards nearly as far as the tubercle of the tibia. The limb is well flexed, the ligamentum patellæ divided, and the joint opened. The skin and subcutaneous tissues are then separated from the anterior surface of the patella, which may be at once removed by a curved incision above it, communicating on either side with that already made below. The flexion is now increased, and the lateral ligaments divided; by this means the interior of the joint is freely exposed, so that the attachments of the crucial ligaments to the tibia can also be severed. The lower end of the femur is then cleared of diseased synovial membrane, so as to allow of the application of a broad excision saw. The usual rule given as to the direction of the saw-cut in the bone is that the exposed bony surface left after removing its articular end should be absolutely horizontal, supposing the patient to be standing upright; personally, we prefer so to make the sections that the limb shall be left very slightly flexed and in-kneed, a position which greatly adds to the subsequent comfort of the patient. To accomplish this, the saw must be applied parallel to the articular surface, *i.e.*, at right angles to the axis of the body, not of the femur, and with a slight upward slant from before backwards. The bone should be partially sawn through by a side-to-side movement, but the posterior surface of the condyles should be divided by raising or depressing the handle of the instrument, so that the structures lying behind in the intercondyloid notch are not encroached upon. Sufficient bone should be sawn off in the adult to include the greater part of the articular cartilage, but as little as possible consistent with removing all the disease, otherwise the limb is shortened to such an extent as to interfere with its subsequent usefulness. The head of the tibia is then protruded, and cleared from the neighbouring soft parts; it is held absolutely vertical, and a saw applied in a horizontal position, the bone being divided from before backwards. Any diseased synovial membrane is now dissected away, special attention being directed to the subcrureal pouch. All bleeding-points having been secured by ligature, the bones are fitted together, and, if considered advisable, secured in position by thick silver wire. The external incision is closed, drainage-tubes being inserted at each angle of the wound. A Gooch's splint is applied to the limb, and in this it remains until sound healing has occurred, after which an immovable case either of plaster of Paris or water-glass is kept on until eight or ten weeks have elapsed since the operation.

The **Ankle-joint** is excised for tubercular disease. Two incisions are made, an inner and an outer. The outer incision runs along the anterior border of the fibula, and curves round the outer malleolus, being about 3 inches in length. The lower end of the fibula is exposed, and by preference subperiosteally. The external lateral ligament is split vertically, and separated from its attachments to the fibula, its continuity with the periosteum being, however, maintained. The fibula is then divided about 1 inch above the tip of the malleolus, and the latter process of bone removed. The periosteum and ligaments are now separated as far as possible from the front and back of the bones. The inner incision is T-shaped, and is made along the inner surface of the tibia, including a short transverse cut at its lower end, which reaches just below the inner malleolus. The periosteum and internal lateral ligament are dealt with as on the outer side, and the front and back of the bones are now easily denuded. The inner malleolus is projected from the wound, and the lower end of the tibia removed by a keyhole saw, the dorsal structures being held aside by a retractor. The articular surface of the astragalus is sawn off from the outer wound, or, if advisable, the whole of the bone may be removed.

The above subperiosteal method of excision is the best of the many that have been suggested. The greatest care should be taken not to open the sheaths of the tendons, and in dressing the wound the foot must be kept at right angles to the leg, and no lateral deviation permitted. As soon as possible it is encased in plaster of Paris, windows being left for the dressing of the wounds, if necessary.

Excision of the **Astragalus** is sometimes called for in the treatment of tubercular disease of contiguous joints. Many methods of operating have been described, but we think it is best accomplished through a single vertical incision over the front of the ankle, running parallel to the vessels and tendons, which are most carefully avoided, and are stripped back by means of periosteal detachers from the dorsum, so that the upper surface of the astragalus can readily be reached. The astragalo-scaphoid and ankle-joints are then freely opened, and the ligamentous and fascial connections on either side severed. The neck of the bone may with advantage be divided at this stage, and its head removed, so as to give access to the under surface and allow of the division of the strong interosseous ligament extending between the adjacent surfaces of the astragalus and os calcis. It may be possible to remove the rest of the bone in one fragment, but it is certainly wiser to break it up with chisel or gouge, and take it away piecemeal.

CHAPTER XX.

DEFORMITIES.

Torticollis.

TORTICOLLIS, or wry-neck, is a deformity produced by a contraction of the sterno-mastoid muscle, whilst the trapezius and deep fascia are frequently affected, and occasionally the short muscles at the back of the neck. It is characterized by the affected side of the head being drawn down towards the shoulder, whilst the face is turned towards the sound side, as shown in Fig. 205. When this has lasted for some time, especially in congenital cases and those commencing in childhood, the affected side of the head and face becomes atrophic. The measurement from the external canthus to the angle of the mouth is smaller, the eyebrow is less arched, the nose deflected, and the cheek less full than on the sound side. Some authorities maintain that even the skull becomes asymmetrical in such cases. No very satisfactory explanation of these phenomena is forthcoming, but it is probably connected with imperfect vascular supply. The cervical spine becomes laterally curved, with its concavity to the affected side, and a secondary compensatory curve is also present in the dorsal region, so as to maintain the eyes as far as possible on a level.

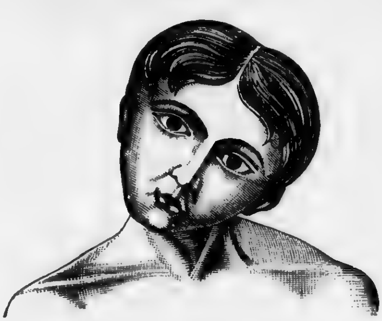

FIG. 205.—TORTICOLLIS. (TILLMANNS.)

The **Causes** and **Varieties** of torticollis may be classified as follows:

1. *Congenital* torticollis, the result of malformation or malposition in utero, or of some intra-uterine muscular contraction or nervous lesion.

2. *Muscular* torticollis, due to intrinsic contraction of the sterno-mastoid, apart from nervous influences, as in cicatricial shortening after intramuscular abscess or gumma. In children it is said to follow the congenital induration of the muscle, so often seen, whilst it is not unfrequently met with as a temporary deformity resulting from cold (rheumatic myositis, or stiff neck).

3. Torticollis arising from *nervous* causes, including spasm and paralysis. *Spasmodic* torticollis (tonic or clonic) may result from (*a*) the direct irritation of the nerve trunk or its roots, as by inflamed cervical glands or cervical caries; (*b*) reflex irritation, as by carious teeth, and possibly worms or ovarian mischief, occurring sometimes in hysterical patients, and usually of the clonic type; and (*c*) from irritation of the deep or cortical centres. This latter variety is usually of the clonic type, and often involves the posterior muscles as well as the sterno-mastoid. It occurs most frequently, though not exclusively, in women of about thirty years of age, and there is often a family history of nervous diseases, such as epilepsy, etc. The prognosis in these cases is almost always unfavourable, since, even if the localized spasm is cured by appropriate operative treatment, other parts are likely to become affected. *Paralytic* torticollis arises either from infantile paralysis of one muscle, leading to unbalanced action of that on the other side, or from some peripheral nerve lesion.

Most commonly the sternal portion is mainly affected, whilst the clavicular half may be quite relaxed. In congenital and cicatricial cases the muscle stands out as a hard tense band, an excess of fibrous tissue being present, or the muscular substance almost entirely absent; but in spasmodic cases the muscle may be well developed and not specially prominent. The deep cervical fascia always becomes secondarily contracted and shortened, and if the deformity has lasted long the posterior cervical muscles are similarly affected, whilst changes in the shape of the cervical vertebræ may also be induced, the bodies becoming wedge-shaped and thickest towards the convexity of the curve.

The **Diagnosis** of torticollis is readily made. It must not be confounded with cicatricial contraction of the skin of the neck following burns, or the attitude temporarily assumed by a patient with an acute deep-seated abscess of the neck, or with tubercular caries of the spine associated with lateral deviation. The rigidity of the neck in the latter case, together with the pain caused by movement or pressure over the vertebræ, should suffice to make the diagnosis clear. Rheumatic contraction of the deeper ligaments and muscles of the cervical spine (rheumatic spondylitis) may also be mistaken for torticollis, but it comes on rapidly, and is associated with tenderness on deep pressure. The fact that in tonic cases the muscle is evidently contracted, and stands out as a tense band in the neck, is sufficiently characteristic. Spasmodic torticollis, again, cannot well be mistaken for any other condition, but it may be difficult to distinguish its cause or to localize the affected muscles.

The **Treatment** of torticollis necessarily varies with the cause upon which it depends, and thus may call for either antiphlogistic, anti-neurotic, anti-rheumatic, or anti-syphilitic remedies. Where, however, it is due to congenital or tonic contraction of the muscle or its tendon, massage and manipulation may be first tried, or even some form of mechanical apparatus; but in the majority of cases tenotomy or myotomy will give a more satisfactory result, and is much less tedious and troublesome.

Two methods of dividing the sterno-mastoid have been employed: (1) The *subcutaneous* operation is a somewhat undesirable proceeding, on account of the important structures placed immediately beneath it. There is but little danger or difficulty in dealing with the sternal head, a tenotome being passed down to it beneath the skin, and the incision made from before backwards; the tension to which it is exposed suffices to draw it well forwards out of harm's way. In dealing with the clavicular portion, it has been recommended to introduce a sharp, and afterwards a blunt, tenotome beneath the muscle, and then divide it from within outwards, whilst others suggest that a director should first be passed beneath it, and then the muscle divided. (2) The *open* method is far preferable to any of these plans, as thereby all danger is obviated. The skin is freely incised across the muscle, its anterior and posterior borders defined, and its fibres carefully and fully divided. No attempt should be made to deal with the portion of deep cervical fascia which passes beneath it and securely covers in the important underlying structures. Any part of the lower half of the muscle may be selected, but the best spot is about ½ inch above the clavicle. The position of the head is then rectified, and fixed by plaster of Paris or some other suitable apparatus. A simple and satisfactory arrangement consists of a padded leather strap passed around the forehead and occiput, and another under the axillæ. A chain or elastic band is secured to the forehead strap above the mastoid process of the side which is not affected, and traction made by fixing it to the front of the lower belt on the opposite side of the body. Thus, if the left sterno-mastoid is contracted and has been divided, the chain is attached over the right mastoid process above and below over the front of the left axilla, traction being thus made in the direction of the right or weakened sterno-mastoid muscle. Where, however, osseous changes are present, the deformity may persist to a great extent, in spite of combined operative and mechanical treatment.

In cases of clonic torticollis it may be necessary to cut down on, and stretch or excise, the spinal accessory nerve (p. 335). This is not attempted until suitable hygienic and tonic treatment has failed. Where the cause is peripheral, good results may follow; but when due to central lesions, we have already stated that failures are not uncommon. In such, division of the posterior cervical nerves will occasionally bring about a cure.

A **Cervical Rib** is a deformity of somewhat unusual occurrence. It arises most frequently from the transverse process of the seventh cervical vertebra, but a similar outgrowth sometimes occurs from the sixth. It is mainly composed of cartilage, but with perhaps some bone in its interior. It passes down behind the nerves to unite with the central portion of the first rib, and occasionally consists of two portions, an upper and a lower, united together by a synchondrosis. No symptoms are produced for many years, but as the mass grows, it tends to compress the brachial plexus, and may push the subclavian vessels forwards, and thus lead to trophic and vascular disturbances, as well as to neuralgia and some weakness or loss of power in the arm. Nothing should be done to this condition unless pressure symptoms are present, when removal may be required. An incision is made parallel to the anterior border of the lower portion of the trapezius; the nerves and vessels are separated from the mass of cartilage and drawn aside, and the growth carefully excised with gouge, chisel, or cutting pliers.

Deformities of the Spine.

Scoliosis.—By scoliosis is meant a condition of lateral curvature of the spine accompanied by rotation of the vertebræ. Conditions are met with in which the spine becomes deflected laterally as an occasional result of Pott's disease, or in fractures; such, however, are not generally considered to be genuine scoliosis.

Ætiology.—The following are the chief causes of scoliosis: 1. It is said to occur very rarely as a congenital deformity, owing to malformation of the vertebræ, but we have never met with a case. 2. It may commence in children at an early period of life as a result of rickets, owing partly to the softened and rarefied condition of the bones, partly to their irregular and uneven growth. It is probably often induced by the method of carrying children on one arm in vogue with nursemaids. A similar change, due to the so-called 'delayed rickets,' may also occur later on in children who are able to run about. The primary curve in this type is usually one directed towards the left in the dorsi-lumbar region. 3. Any condition of asymmetry of the body may lead to what is known as *statical scoliosis*, *e.g.*, congenital shortness of one leg, unilateral dislocation of the hip, contractions of the knee or hip joints, genu valgum, falling in of the chest wall as a result of empyema, and even old-standing torticollis. If the cause exists in one of the lower extremities, the pelvis is tilted down on the shorter side, producing a lumbar curve with the convexity towards the side of the shortened leg, whilst a compensatory dorsal curve in the opposite direction is subsequently added in order to maintain the general axis of the body. When due to a cured empyema, a primary dorsal curvature is produced, with its convexity towards the sound side. In torticollis the cervical curve is primary, and a compensatory curve in the opposite direction in the dorsal region usually follows. 4. The most common form of scoliosis, however, is that known as the *scoliosis of adolescents*, met with in young people about the age of puberty, or a little older, who are in a weak and asthenic condition, often as a result of excessive growth, combined possibly with improper food, defective hygienic surroundings, or exposure to hard work, whereby muscular fatigue is induced. Young women of an anæmic type who suffer from amenorrhœa, and who as housemaids or factory hands have to undertake a good deal of lifting, are especially liable to this con-

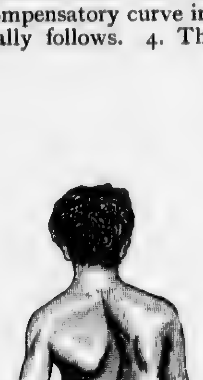

FIG. 206.—SCOLIOSIS SEEN FROM BEHIND. (TILLMANNS.)

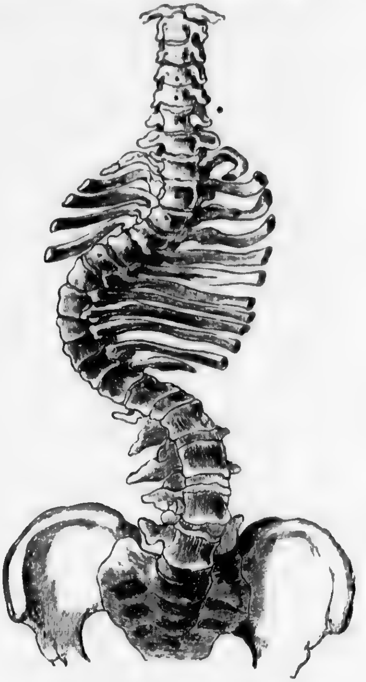

FIG. 207.—SPINE IN SCOLIOSIS SEEN FROM IN FRONT. (TILLMANNS.)

dition. It is due to a relaxed state of the ligaments and muscles, being not unfrequently associated with flat foot and genu valgum. Prolonged standing in a position of ease or rest, in which the weight is mainly carried on one leg, may determine its occurrence, as also faulty positions occupied by children at school, owing to low desks and want of support to the feet. As a rule, the lumbar curve forms first, its convexity being to the left side, a compensatory dorsal curve, with its convexity to the right, being subsequently developed.

The **Phenomena** resulting from lateral curvature of the spine may be most readily considered by describing the usual form met with—that is, where the dorsal convexity is to the right, and the lumbar to the left (Fig. 206). In the opposite condition all that is necessary is to transpose the words 'right' and 'left' in the following description.

In addition to the lateral displacement, *rotation of the bodies of the vertebræ* (Fig. 207) towards the convexity of the curves is always present. This is probably merely a mechanical act, and due to the more firm support given to, and the interlocking of, the posterior parts of the vertebræ. As a result of this the spinous processes are directed towards the concavity, and hence will always indicate a smaller amount of distortion than really exists. Occasionally there may be some backward projection of the spines at the junction of the two curves.

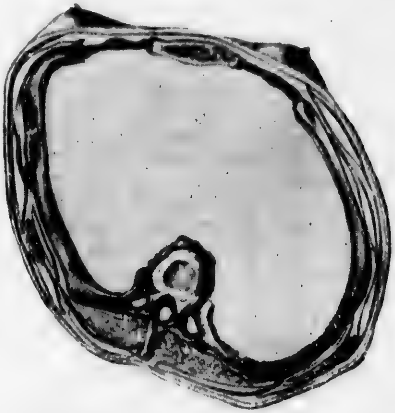
FIG. 208.—SECTION OF THORAX IN SCOLIOSIS. (AFTER HOLMES AND HULKE.)

The *thoracic walls* necessarily participate in the process. The ribs on the right side become to some extent separated from one another, and project posteriorly on account of the rotation of the vertebræ; the amount of curvature at the angle is consequently increased, whilst the front of the chest on this side of the body becomes flattened. On the left side the ribs are huddled together, and the curve at the angle diminished, the ribs being thereby opened out; consequently the thorax is flattened posteriorly on that side, but projects in front; the left breast may thus be rendered prominent (Fig. 208). In fact, the thorax becomes more or less rhomboidal in shape. The sternum also is somewhat displaced or twisted, the anterior surface looking towards the right. The capacity of the thorax is not as a rule affected at first, but in the later stages it is considerably diminished, and the abdominal viscera may even be displaced. The *scapulæ* follow the thoracic wall, and hence the right shoulder is displaced upwards and outwards, and this, it is said, in the worst cases may progress to such an extent as to cause the sternal end of the clavicle to be spontaneously dislocated backwards. It is for this 'growing out of the shoulder' in young women that the majority of cases come under observation. The left scapula is usually somewhat lower than the right. The effect on the *waist* also varies; on the right side the true waist becomes more marked than usual, corresponding to the lumbar concavity, and in advanced cases a distinct sulcus may be present between the lower ribs and the crest of the ilium, which is thought to be 'growing out.' On the left side the true waist becomes flattened, owing to the projection of the lumbar vertebræ, whilst the dorsal concavity higher up may simulate a false waist. In addition to the above phenomena, the buttocks may be noticed to be asymmetrical, the pelvis being tilted down on the left side. The erector spinæ muscle stands out unduly on the left, owing to the rotation of the vertebræ, whilst the transverse processes on this side may be unusually evident.

In the early stages the characteristic deformity disappears on extension of the trunk, as by hanging from a trapeze, or on bending forwards; but as it progresses, the spine becomes more and more fixed, and but little alteration is produced by suspension of the patient. In the worst cases the deformity becomes so marked as to simulate the 'hump' formed in Pott's disease, and the patient's stature becomes dwarfed and stunted.

Subjective symptoms, such as neuralgic pain and weakness, are also present, but they are not very prominent features in the case.

Anatomical Changes.—The structure of the spinal column is at first not manifestly altered, but as soon as the deformity becomes chronic, the individual vertebræ become evidently misshapen. The bodies are somewhat wedge-like on section, being thicker on the convex than on the concave side. The *intervertebral discs* are similarly changed, whilst the *articular processes* are unduly pressed together on the concave side, and separated from one another on the convex. The transverse and spinous processes are also approximated to one another on the side of the concavity, and may become curved. The *ligaments*, which in the early stages are relaxed, become secondarily shortened on the concave side, and may, indeed, disappear, the bodies of the vertebræ being ankylosed. The *muscles* are similarly affected, being relaxed in the early stages, but accommodating themselves afterwards to the altered curves of the spine, and hence are contracted on the concave side, and stretched on the convex.

It is most essential that a correct **Diagnosis** be made as soon as possible, since so much depends upon treatment being early instituted. A thorough examination should be made with the clothes stripped to below the waist, so that the whole back can be seen. The patient should be made to sit straight up on a stool or chair placed sideways, and the surgeon stands behind her. The general appearance is first noted, and then the spinous processes are marked out one after another with a spot of ink or with a flesh pencil. The shape of the thorax, the curvature of the ribs, and the position of the scapulæ, are also ascertained. The patient is then made to stand, to hang from a bar, and to bend forwards, and the effects of these respective movements noted; by this means some idea can be obtained of the extent and nature of the deformity. There can be but little risk of mistaking it for Pott's disease, since the rigidity, deformity, and localized pain of the latter are so characteristic; in those cases of scoliosis, however, where there is a projection of the spinous processes backwards, a mistake might easily arise if only a careless examination were made.

The **Prognosis** necessarily varies with the stage which the affection has reached. In early days, before the deformity has become set, and when it disappears on extension of the spine, it is almost certain to be entirely cured, if suitable precautions are taken. Later on it can be improved to some extent, but in very bad cases all that can be expected is to prevent it from getting worse.

In the **Treatment** of scoliosis, the cause of the trouble must not be overlooked, since in many cases the deformity may be remedied, or at any rate prevented from increasing, by attending to this. Thus, inequality in the length of the limbs necessitates the wearing of a high-heeled boot, whilst contractions of the knee or hip joints should, if possible, be remedied. In that variety which occurs in young people from general or local debility, the general health must be improved by a visit to the seaside, or the administration of tonics, such as iron and arsenic. Carefully regulated rest and exercise must also be recommended, so as to improve the muscular tone of the back without unduly fatiguing the patient; for a similar reason massage and cold baths are beneficial. All errors of position must be corrected, and suitable desks, forms, and chairs utilized. In the slighter cases it often suffices to order the patient to rest in the supine position on an inclined board for an hour or two daily, the head being thus raised and the spine extended. Calisthenic movements and gymnastic exercises, especially on the horizontal bar and trapeze, are also valuable. Of course, these must be arranged so as to exercise the weak muscles and counteract the deformity. Space forbids us describing them here, and we must refer readers to special text-books. A spinal support is often useful, but should not be worn too continuously, as it tends to render the muscles of the back weak from disuse. All that is needed in the early stages is the support of a firm, carefully-fitted corset; but should the deformity increase, stronger steel instruments may be employed in which springs are incorporated, whereby it is hoped that correction of the curvature may be brought about. In the more severe cases, which are often associated with considerable pain, such a contrivance with axillary crutches is absolutely essential. Plaster of Paris, applied according to Sayre's method, is certainly objectionable, since it is irremovable, and all other local treatment to the back is thus prevented.

Kyphosis.—By this term is meant a condition of increased dorsal convexity of the back (Fig. 209), which is not uncommonly associated with loss of the lumbar concavity, so that the whole spine is bent forwards. Occasionally, however, a marked lumbar lordosis is present as a compensatory condition.

The chief **varieties** of kyphosis are as follows:

1. Kyphosis from defective growth or habit. This may occur (*a*) in young people under the age of four, resulting from rickets; (*b*) in adolescents up to the age of sixteen (round shoulders), from a continuous habit of stooping, as in reading or writing, and is not uncommon in those suffering from myopia; (*c*) various forms of occupation, involving the carrying of heavy weights, or stooping over work, will lead to its appearance in adults, as in porters and cobblers, whilst the use of bicycles, which necessitate the riders stooping forwards in order to grasp the handles, is becoming a frequent source of this deformity; (*d*) in old men it is often met with as a result of senile atrophy

2. Kyphosis from general diseases of the spine is a marked feature in osteo-arthritis, osteitis deformans, osteo-malacia, hypertrophic pulmonary osteo-arthropathy, and acromegaly. In the latter disease the condition is limited to the dorsal region, lordosis being present below.

3. Kyphosis from localized disease of the spine is sometimes described, although it is more commonly known under the contradictory term of 'angular curvature.' It results from fractures, Pott's disease, gumma, or cancer (*q.v.*).

Treatment is impossible in the majority of cases, but the round shoulders of young people come so commonly under the observation of the surgeon that a little more notice of the condition is needed.

Round Shoulders occur most frequently in girls who have grown rapidly, and perhaps developed precociously. They are often due to defective habits of sitting and standing, especially at school, and may be induced by faulty desks and chairs, whilst other intrinsic conditions, such as myopia or adenoids, may also be primarily responsible. The spine becomes bent forwards in the cervico-dorsal region; and at first the deformity can be voluntarily corrected, but not so later on.

Treatment.—A thorough investigation must be made into the question of causation, and all removable conditions dealt with. The essential point in the treatment is to increase the power of the muscles of the back, especially the trapezii, the erectores spinæ, the rhomboidei, and the serrati. This may be accomplished by massage, electricity, and exercises, the latter necessarily directed towards extension of the back. The girl should never be allowed to fatigue herself unduly, and must rest on her back two or three times a day for half an hour. At night no bolster should be used, the child lying on her back, with the pillow beneath the curve. The general nutrition and health must also be attended to, and a course of suitable tonics prescribed.

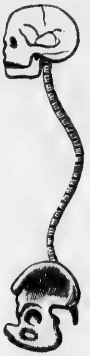

FIG. 209.—KYPHOSIS. (AFTER ERICHSEN.)

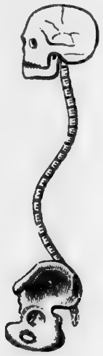

FIG. 210.—LORDOSIS. (AFTER ERICHSEN.)

Lordosis (Fig. 210) consists in an increased anterior curvature of the spine in the lumbar region. It is usually produced by continued flexion of the hip, whether due to congenital displacement, to unreduced dislocation, or to hip disease, and in such cases it is irremediable unless the malposition of the femur can be corrected.

It is seen as a temporary condition in pregnancy, and as a more constant phenomenon in bad cases of uterine fibroids, owing to the increased weight of the uterus or its contents, necessitating backward displacement of the upper part of the spine in order to adjust correctly the centre of gravity of the body. The same may be noticed in people with large, fat, and pendulous abdomens.

It is occasionally present in progressive muscular atrophy where the lumbar and abdominal muscles are weakened, and usually in pseudo-hypertrophic paralysis from loss of power in the gastrocnemii and other muscles engaged in maintaining the erect posture. In both cases the centre of gravity of the body is displaced forwards, necessitating the throwing backwards of the head and shoulders in order to maintain the equilibrium of the body.

Spondylo-listhesis is the term applied to a curious and somewhat uncommon deformity, in which the lumbar vertebræ are displaced downwards and forwards from the top of the sacrum. It arises from fracture of the articular processes of the lumbo-sacral synchondrosis, or from imperfect development of the laminæ or pedicles of the lowest lumbar vertebra, as a result of which the pressure of loads carried on the shoulders or the weight of a pregnant uterus brings about the displacement. In the latter instance the enforced lordosis aggravates this tendency. The effects produced are shortening of the stature, together with the formation of a marked hollow above the sacrum, whilst the lumbar vertebræ are unduly prominent anteriorly. A good deal of neuralgic pain and weakness are also caused. The only *treatment* is prolonged rest in the recumbent posture, and possibly the application of a well-fitting leather jacket, closely moulded to the pelvis, and supplied with crutches, so as to carry part of the weight downwards from the axilla to the pelvic support without utilizing the spine.

Deformities of the Upper Extremity.

Many different forms of congenital defect have been noticed in connection with the arms and hands, but the majority are so uncommon that no particular mention of them is needed. Various types of **Club-hand** have been met with, in which the hand is deflected to one or the other side, or is hyper-extended or flexed. Perhaps the most frequent cause is a *congenital absence of the radius*, under which circumstances the hand is radially abducted to a marked degree, the ulna is shortened and curved, and its lower epiphysis much altered in shape. In any of these deformities skiagraphy should be employed, so as to ascertain the exact relations of the bones to each other.

Congenital Deformities of the Finger are much more common, and the account here given of such defects of the upper extremity applies with equal force to those which occur in the lower. The following varieties may be alluded to:

Polydactylism consists in the presence of supernumerary fingers and toes, and is often seen. There may be from one to seven additional digits, and the condition is usually symmetrical. One case is on record with twelve and thirteen fingers on the hands, and twelve toes on each foot. The accessory digits are often stunted, and smaller in size than the normal, but may be of average dimensions. Usually they are separated from the true digits, but now and then may be blended with them. The correct number of metacarpal and metatarsal bones may be present, or they also may be multiplied. Fig. 211 is an excellent skiagram of such a case, where it will be noticed that there are six digits and six metatarsal bones, whilst it is also evident that the last two digits are supported by an accessory metatarsal apparently springing from the outer side of the fourth. The condition is frequently inherited. The *Treatment* consists in removing the supernumerary digits, if useless, obtrusive, or troublesome. Sometimes the patients are proud of their abnormality, and refuse to part with it. A patient with two weak thumbs may sometimes be benefited by uniting them laterally into a single broad one.

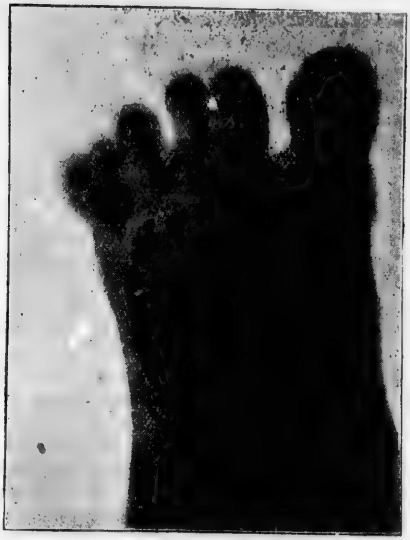

FIG. 211.—SKIAGRAM OF POLYDACTYLISM.

An exostosis is present, springing from the base of the second metatarsal bone; the last two digits are supported by an accessory metatarsal, placed between the normal fourth and fifth, whilst the fifth has no toe supported by it.

Ectrodactylism, or the absence of one or more of the digits, is occasionally seen, as also partial arrests of development of fingers or toes.

Macrodactyly consists in a congenital overgrowth of one or more fingers or toes. The structures are perfectly normal in character, and merely gigantic in size for the age of the individual. Amputation may be needed in these cases, as the deformed parts grow out of all proportion to the neighbouring tissues. Thus an infant with enormous overgrowth of the second toe of the right foot was successfully treated by excision of the digit, together with a V-shaped portion of the foot, which was by this means reduced to normal shape and size.

Syndactylism, or webbed fingers, is a condition in which two or more fingers are joined together laterally, either by a thin web consisting mainly of skin, or by a thick fleshy bond of union. In the foot no *treatment* is required, but in the hand the fingers must be separated. If there is merely a thin web, this may be divided by scissors; but to prevent its re-formation from below upwards, as healing proceeds, a flap of skin must be transplanted into the angle between the fingers, or an opening in the base of the web may be made and maintained, and the edges allowed to cicatrize before the web itself is divided. Where the union, however, is thick and fleshy, a more extensive operation is needed. Two flaps of skin as long as the web, and half the width of a finger, are respectively raised from the dorsal aspect of one finger and from the palmar aspect of the other, in such a manner that, after the web has been divided, the denuded surfaces can be covered by wrapping the flaps round the lateral aspects of the fingers and suturing them in position. An additional flap of skin must also be fixed in the angle between the separated digits, unless the preliminary measure just described has been undertaken.

Of the **Acquired Deformities of the Hand**, Dupuytren's contraction is the most important, but a few others are occasionally met with. Thus, after burns the hand may be contracted into a useless mass in which the fingers are drawn into the palm and united by cicatricial tissue to the palmar structures, so that all treatment is hopeless.

Again, after injury or separation of one of the epiphyses of either radius or ulna, the uninjured bone may continue its growth, whilst the other becomes atrophic in such a way that considerable lateral deviation of the hand is thereby brought about.

The term **Mallet Finger** has been applied to a condition in which the terminal phalanx is maintained in a state of flexion owing to some damage to the extensor aponeurosis. It usually follows slight injuries, which lead to either a separation of the tendon from the bone, or a thinning of its texture, whereby the flexor tendon attached anteriorly to its base is able to act with undue power. The *treatment* consists in the application of an anterior finger-splint in the early stages, but later on, when the deformity is persistent, an incision is made on the posterior aspect of the joint, and the weak tendon isolated and stitched down in such a way as to give it a better attachment to the bone.

Contraction of the Palmar Fascia (Dupuytren's Contraction).—This condition is usually met with in middle-aged individuals of a gouty temperament, more often in men than women, and not unfrequently on both sides of the body. It may or may not be associated with some direct irritation of the palm, as by leaning much on a round-headed cane, or from the constant use of an instrument, such as an awl, whilst heredity is an important causative factor. Pathologically, it is due to a chronic overgrowth and contraction of the fascia, inflammatory in nature, and cirrhotic or sclerosing in type. It commences as an indurated subcutaneous nodule in the palm of the hand, about the situation of the most marked transverse crease, and affecting most commonly the ring and little fingers first, the other fingers and thumb being less often involved. The induration spreads slowly both up and down the fascial bands into the fingers, which, as it increases, are gradually drawn up into the palm and fixed, so that extension becomes impossible (Fig. 212). The flexion is limited to the first and second phalanges, the third remaining extended, and, indeed, sometimes assuming a position of hyper-extension, owing to the injudicious application of a splint. The skin over the indurated masses is sooner or later incorporated with them.

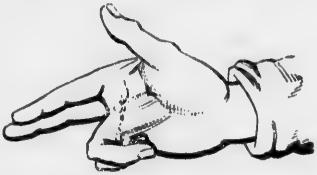
FIG. 212.—DUPUYTREN'S CONTRACTION OF THE HAND.

The **Diagnosis** of Dupuytren's contraction is exceedingly easy, the only condition for which it is likely to be mistaken being flexion of the finger due to contraction of the long tendons. In the latter case there is, as a rule, no palmar induration, and on attempting to straighten the finger the tendons may be felt to become tense above the wrist; the terminal phalanx is also flexed in many instances.

The only satisfactory **Treatment** is by operation, and the following methods are those which are most successful: (*a*) Adams' subcutaneous section of the fascia and its prolongations consists in dividing the indurated bands by a tenotome in several places, where they can be felt tense. One puncture and division must be made in the centre of the palm; a second divides the same band as near the finger as possible, whilst the third and fourth deal with the lateral prolongations at the sides of the finger; if other bands still exist, they are treated similarly, the tenotome, if possible, in all cases being inserted between the skin and the fascia. The improvement thus produced must be maintained and increased by the subsequent use of suitable apparatus and passive movements. (*b*) Kocher's method consists in the total extirpation of the thickened bands and their prolongations through longitudinal incisions. The fingers are at once straightened, and the subsequent contraction prevented by mechanical appliances. Probably the latter operation is the more satisfactory.

Deformities of the Lower Extremity.

Coxa Vara, or incurvation of the neck of the femur, is a condition to which attention has been called only of recent years. The neck of the bone, instead of passing obliquely upwards, is horizontal, or even in bad cases directed downwards, whilst shortening from interstitial absorption also occurs, and the head becomes mushroom-shaped. At first the osseous tissue is softened, but after a while sclerosis supervenes. It is met with usually in adolescents, although occasionally it occurs in young children. It is supposed to be due to a late manifestation of rickets, but, since it is often unaccompanied by other evidences of the disease, this hypothesis is a little difficult to accept. Certainly, it is seen most frequently in those who have to do much walking or carrying of heavy weights.

The **Symptoms** commence with pain in the region of the hip, followed by a distinct limp. As the neck of the bone becomes absorbed or curved, the trochanter rises above Nélaton's line, and real shortening of the limb occurs, even up to 1½ inches. The limb is also everted and the trochanter increasingly prominent, especially on flexing the thighs. The movements of the joint are limited, particularly in the direction of internal rotation and abduction, the latter being practically impossible in the more severe cases, owing to the base of the trochanter hitching against the lip of the acetabulum. On flexing the limb, the affected thigh sometimes lies across the sound one. As distinguishing features may be mentioned: the absence of local swelling or tenderness on pressure, as also of the up-and-down movement on traction, so well marked in congenital dislocation, whilst suppuration never follows, and thickening of the trochanter is not observed.

Treatment.—In the early stages rest is *the* essential, and thereby any increase in the deformity already existing is prevented; local massage and manipulation are also advisable. In the later stages, excision of the head, or subtrochanteric osteotomy, are perhaps the best measures to undertake, although some surgeons recommend a cuneiform osteotomy of the neck alone. The subsequent shortening may be dealt with by means of a thick sole to the under surface of the boot.

Genu Valgum, or knock-knee, is a deformity in which, if the knees be allowed to touch with the patellæ looking forwards, the malleoli are separated one from the other—*i.e.*, it is a fixed condition of abduction of the legs from the middle line, with some external rotation (Fig. 213). One or both limbs may be affected, but if due to general causes the double form is more common. Occasionally genu valgum occurs in one leg, whilst the other is in a condition of genu varum.

There are two main **varieties** of the disease, viz.: (1) The rachitic genu valgum of young children, and (2) the static form occurring in adolescents.

The genu valgum of young children is practically always due to *rickets*, a disease associated with a softened condition of the bony tissue on either side of the epiphyses, which results in an interference with the normal development. It is still an open question as to whether this deformity is primarily due to increased growth in the internal condyle, or to arrest of development in the external; the truth probably lies between the two. A similar state of affairs is often seen in the tibial tuberosities. Other cases may arise from a rachitic curvature of the diaphysis of the femur, especially when the child has been allowed to walk or run about too early.

The genu valgum of adolescents, or static genu valgum, occurs most commonly in young people under twenty of relaxed constitution, and particularly in those who, in addition, have to carry heavy weights. Thus, anæmic young women who act as nursemaids, and young bricklayers, smiths, and porters, are very liable to it. There are many different opinions as to the way in which it is produced: some maintain that it is primarily osseous, and due to a delayed rickets; some believe that the ligaments are chiefly at fault, being relaxed on the inner side; whilst others, again, maintain that it is primarily a muscular phenomenon.

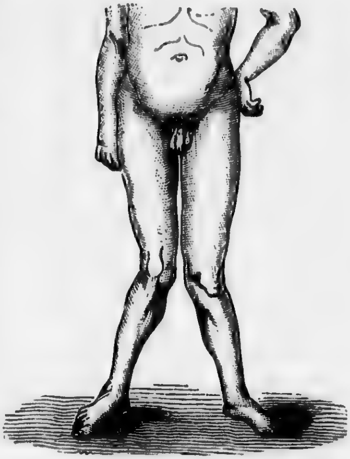

FIG. 213.—GENU VALGUM. (TILLMANNS.)

Possibly several of these causes may be conjoined in any particular case, but the most likely explanation is a purely mechanical one. When a person stands in the erect posture, the perpendicular line which represents the direction in which the weight is transmitted downwards from the head of the femur passes through the outer rather than the inner condyle, whilst the latter structure is lengthened in order to maintain the horizontal position of the articular surfaces of the knee-joint. A certain amount of strain is thus normally cast upon the internal lateral ligament even in a healthy person, and this is increased as the natural position of rest—*i.e.*, with the feet separated and slightly abducted

—is adopted. A long continuance of this posture, especially if a certain amount of additional weight has to be carried, tires those muscles of the limb which tend to counterbalance this strain, so that the ligament becomes more and more stretched, and not unfrequently a certain amount of lateral mobility is noticed at the knee in consequence. Concurrently the outer condyle becomes atrophied from more weight being transmitted through it, and the inner condyle becomes lengthened from overgrowth. It is also important to note that flatfoot and lateral curvature of the spine often accompany this form of genu valgum, the former being usually also due to ligamentous relaxation, whilst the latter may be merely associated with it, or be compensatory if the deformity in the knee is unilateral.

Occasionally genu valgum is due to *traumatic causes*, such as fracture of the tibia or femur close to the joint, or lateral dislocation of the knee; whilst, again, it may be caused by atrophy consequent on interference with the epiphysis from local injury or diseases other than rickets. It is sometimes observed as a result of riding, in those with long legs, as in cavalry soldiers; short-legged individuals, such as jockeys, are more liable to develop a condition of genu varum.

The **Physical Condition** of the parts about the knee may be summarized as follows:

(*a*) A marked projection exists on the inner side of the knee, due to overgrowth of the inner condyle of the femur, an increase mainly in the vertical and transverse directions, and but very slightly antero-posteriorly, so that, on flexion of the joint, the deformity to a large extent disappears. A similar condition may obtain in the inner tuberosity of the tibia.

(*b*) Impaired growth and atrophy is observed in the outer femoral condyle and tibial tuberosity, conditions supposed to be due to the weight of the body being transmitted more directly through these structures.

(*c*) Relaxation of the ligamentous and muscular tissues takes place on the inner side of the joint. This, however, is not constant, especially in cases which are stationary.

(*d*) The tendons and ligaments on the outer aspect of the joint are contracted and shortened, especially the external lateral ligament, the ilio-tibial band, and the tendon of the biceps.

(*e*) The patella tends to be thrown outwards from the angular deformity existing at the knee-joint. Occasionally the bone is actually dislocated, and when this has once happened it is very likely to recur.

The following secondary conditions may be met with resulting from genu valgum, viz.: The feet are displaced outwards, or occasionally inwards, as best suits the convenience of the patient in obtaining as good a footing as possible; the bones of the legs and of the thighs are often bent; whilst, if unilateral, the pelvis may be tilted downwards on the affected side, and the spine laterally curved on account of the unnatural shortness of the limb.

In well-marked cases the gait of the patient is very characteristic, since the knees tend to get in the way of each other; hence the term 'knock-knee.' The legs are kept partially flexed, and as the condyles touch or overlap, they have to be separated at each step to allow of progression, and thus a curious rolling sort of walk results. Occasionally bursæ form over the points where the friction is most marked.

Treatment.—The surgeon must study each particular case in order to ascertain, not only the cause of the trouble, but also whether or not it has advanced to such a stage as to render treatment other than operative useless. In the early stages of a rachitic knock-knee, the bones are still soft and vascular, so that with care and patience the deformity may be remedied without having recourse to the knife, and the same statement is true of the early stages of the static variety.

In *rachitic* infants, therefore, the general condition must be dealt with in accordance with the rules given elsewhere (p. 544). A suitable diet should be ordered, cleanliness attended to, and plenty of fresh air allowed. Parrish's food is perhaps the best drug to administer, whilst cod-liver oil is rarely needed, since it tends to increase the body-weight, and so may do harm rather than good. Absolute rest in bed should be enforced; the limbs must be well rubbed daily, and such manipulation and pressure employed as will tend to remedy the deformity and straighten, if possible, the limb. No pain should be caused, and by perseverance slow but appreciable progress may be made until the limbs are straight. In older children, especially when there is some difficulty in keeping them off their feet, it is better to apply splints on the outer side of the limbs, reaching from the pelvis down to the outer malleoli, or, if need be, beyond it. These are retained in position by water-glass bandages, put on sufficiently firmly to draw the knees outwards. Such an arrangement is often sufficient in early cases to bring about a cure in the course of a few months. Some authorities have recommended forcible correction of the deformity, and subsequent fixation in plaster of Paris, but the condition of the epiphyses, and the ease with which they are detached, are quite sufficient reasons against adopting any such method.

In the *static* cases the administration of tonics, such as iron and arsenic, combined with rest, massage, and possibly a change of air, will frequently suffice to determine a cure in the early stages.

When the deformity is somewhat more advanced in either form, more efficient apparatus is needed; that usually employed consists of an outside iron stem, jointed at the knee, fixed below into a slot in the heel of a well-made boot, and attached above to a pelvic band. From it several well-padded straps pass round the limb, and at the knee itself a much broader one covers the projecting inner condyle; by tightening these, the limb is drawn outwards towards the rod. The apparatus is somewhat heavy, but if carefully applied for some months may effect a cure. It is possible that division of the tense structures on the outer side of the joint may considerably assist the process.

When, however, the osseous deformity is marked, and the patient of such an age as to preclude the hope of a cure by mechanical means, *osteotomy* must be resorted to. Amongst the many plans which have been suggested, only two need be mentioned here, viz., those devised by Ogston and Macewen. *Ogston's operation* consists in sawing off the enlarged inner condyle through an incision made by inserting a narrow finger-knife obliquely above the condyle, and pushing it downwards in front of the bone to the level of the joint. The objections raised to the plan are the necessary implication of the joint and of the epiphyseal cartilage, so that ankylosis may occur on the one hand, or such interference with the growth of the inner condyle, on the other, as leads later on to genu varum. The immediate result is very satisfactory, and it may be used with success in adults where no more growth is expected. *Macewen's operation* is, however, that most generally applicable, and has practically superseded all others. It consists in the division of the femur transversely about a finger's breadth above the adductor tubercle, so as to be well away from the epiphyseal cartilage. Macewen himself uses an osteotome* for the purpose, introducing it through an incision made ½ inch in front of the tendon of the adductor magnus; he divides the bone for three-quarters of its diameter, and breaks the remainder. A similar method may be employed from the outer side, the force used in breaking the inner layer of compact bone comminuting and compressing that portion, and so diminishing the deformity. Many surgeons, however, prefer to divide the bone with a saw, previously making a track for it along the front of the femur, and we certainly consider that such an operation is simpler, and equally efficacious. The limb, having been straightened, is either put up at once in plaster of Paris, or, perhaps, at first in a Gooch's splint, which allows the wound to be looked at and dressed, and subsequently in plaster. Union is complete in six weeks, but an immovable apparatus should be kept on for three months.

In a few very severe cases due to rickets it may be necessary to divide the tibia just below the tubercle in addition to dealing with the femur. This is best accomplished as a first step, and if necessary the fibula may also be divided. When this wound has consolidated, the femur is dealt with.

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* An *osteotome* differs from a *chisel* in the fact that the former is bevelled on both sides, whilst the latter is merely bevelled on one side.

Genu Varum (one form of *bow-leg*) is a less common condition, the exact opposite of genu valgum, and what has been said above of the one is true of the other, if the word 'internal' be substituted for 'external' and *vice versa.* Treatment is only required in severe cases.

Genu Recurvatum, or *Back-knee*, is a deformity occasionally met with in which the joint is hyperextended, the limb describing a curve with the concavity forwards; it is necessarily associated with relaxation or stretching of the crucial ligaments, and is usually due to a congenital displacement, possibly the result of the limbs not being flexed *in utero*, but extended with the feet under the chin. It is sometimes the result of paralysis of the flexor muscles of the knee and of the popliteus, or may arise from irregular growth along the epiphyseal line, possibly as a sequela of tubercular or other disease of limited extent in that region. It has also been known to occur as an acquired accomplishment in fakirs and contortionists. If treatment is called for, it must be suited to the special requirements of the individual case.

Contractions of the Knee may arise from many different causes, which may be either intra- or extra-articular in character. The *extra-articular* causes of this affection may be situated in the *skin* and subcutaneous tissue, as a result of the contraction of cicatrices of burns or ulcers; or it may be due to the contraction of *muscles*, which may be secondary to some inflammatory condition within the joint, or may follow loss of power in the extensors as a result of infantile palsy, or may be due to diffuse suppuration within their sheaths. The contraction in some cases may be *hysterical* in origin, the joint being fixed by muscular action, but remaining healthy, although there may be much local pain and superficial tenderness. The diagnosis of such a condition is readily made by inducing anæsthesia, or taking the patient unawares, when the limb is found freely moveable and can easily be straightened. The treatment of the preceding conditions is conducted on general principles.

The *articular* causes of contracted knee are as follows: (1) Where the capsule and ligaments are affected as well as the muscles, the causative inflammation having been usually of a rheumatic or gonorrhœal nature. The limb is fixed, but there is no actual displacement of the head of the tibia. (2) Fibrous adhesions of greater or less density may pass between the articular surfaces, as a result either of acute synovitis, or of tubercular or acute arthritis. In the former case some mobility may be present, but in the latter the movements may be very defective. (3) Osseous ankylosis may exist, the position of the limb depending on the previous treatment of the case. If care has not been taken to prevent deformity, the lower leg may be found at right angles to the thigh, and more or less everted. This rectangular deformity is a not uncommon development in the later history of a case of tubercular disease of the knee, which has been treated early in life by partial excision. The epiphyses are here only slightly interfered with, and hence growth continues, but not equally in all directions. Where the anterior portion of the bone develops more than the posterior, flexion necessarily occurs; but if the growth is mainly in the opposite direction genu recurvatum may be induced. (4) As the result most commonly of tubercular arthritis, the tibia is flexed on the femur, whilst its upper articular surface is displaced horizontally backwards, and the lower limb rotated outwards, constituting what is known as the *triple displacement*. If the limb has been allowed to lie on its outer side whilst disorganization was proceeding, there may be an additional lateral displacement of the head of the tibia outwards.

The **Treatment** of these conditions necessarily depends on their nature. Where adhesions exist within the joint, or the ligaments alone are contracted, it may be possible to straighten the limb under an anæsthetic by forcible manipulation. Where the contraction is associated with osseous ankylosis, a suitable wedge-shaped piece of bone (*cuneiform osteotomy*) should be removed. In the triple displacement ordinary excision may be undertaken, but the process is difficult, owing to the backward displacement of the tibia. The bones should be kept in position by silver wire sutures, or other means.

Rachitic Tibia and Fibula.—It has been already mentioned that the tibia and fibula are liable to a considerable amount of distortion in the course of an attack of rickets if the child is allowed to run about. As a rule the antero-posterior curve is increased, and some amount of ab- or ad-duction may also be present. The bones, too, are usually flattened from side to side, presenting a sharp edge, and with a buttress-like support reaching along the concavity; they are exceedingly dense and sclerosed. Operations for remedying the defect should never be undertaken, however, until all active signs of rickets have disappeared. Osteotomy may then be performed, and the character of the operation will necessarily vary with the amount of deformity. The general rule for the guidance of the surgeon is either to divide the bones at their most prominent part, or, if it is considered necessary, to remove a wedge-shaped portion from the tibia (*cuneiform osteotomy*); the section should always be made at right angles to the upper and lower segments of the bone respectively. The fibula never needs more than simple division, and this is accomplished through a separate incision.

As mentioned elsewhere, the tibia and fibula also become distorted and curved antero-posteriorly as the result of *inherited* *syphilis.* The deformity in this case is purely antero-posterior, without lateral deviation, whilst the subcutaneous margin of the tibia is rounded, and not sharp as in rickets. Moreover, the curve is mainly placed in the centre of the shaft, whilst in rickets the chief deformity occurs either near the knee or the ankle. There ought, therefore, to be but little difficulty in distinguishing these two conditions, and a careful inquiry as to the previous history of the case should materially assist the surgeon in forming a correct diagnosis.

Talipes.

By talipes, or club-foot, is meant a deformity of the foot due to muscular, ligamentous, or osseous causes, the displacements occurring mainly at the ankle and mid-tarsal joints.

Causes.—Talipes may generally be said to result from some derangement in the equilibrium normally maintained between opposing groups of muscles, as a result of which the more powerful group draws the foot into an abnormal position. Considered more in detail, it is well to study the ætiology of the acquired and congenital forms separately.

Congenital malformation or malposition is responsible for a certain percentage of the cases. Such may result from imperfect development of the bones of the foot or leg, or from intra-uterine paralysis of central origin; whilst other cases seem to be due to a deficient amount of liquor amnii, as a result of which the feet are abnormally compressed, and held in one position. It must be remembered in this connection that in the fœtus the legs should always be in a state of flexion, and the feet usually in the position corresponding to that of talipes varus; it is easy then to understand that in an abnormally small intra-uterine cavity this tendency may be exaggerated. Spina bifida in the lumbar region is also occasionally associated with congenital talipes, which in such cases is probably due to impairment of nervous control. The congenital variety is often hereditary, and may occur in several members of the same family, or be transmitted through several generations.

The *acquired* varieties are somewhat easier to understand than the congenital, since they arise from definite pathological lesions, such as: (*a*) Contraction of muscles, the result of diffuse suppuration, arising from burns or disease of neighbouring bones; thus, necrosis and disease of the tibia may lead to the formation of an abscess in the sheaths of the tibialis anticus or posticus, and contraction of one or both of these muscles may cause talipes varus. (*b*) Essential shrinking, resulting from a transformation of the muscle substance into fibro-cicatricial tissue, is occasionally met with in elderly people arising from a chronic inflammation (myositis fibrosa), the nature of which is but little understood. (*c*) Paralysis of central origin is one of the commonest causes of talipes; in young children it is usually due to infantile palsy (anterior polio-myelitis), whilst a similar affection is occasionally seen in adults. (*d*) Affections of the main peripheral nerve trunks of the leg may also result in talipes; thus, a nerve may be divided in an accident or operation, or torn in a fracture or dislocation, or compressed by callus or splints, or inflamed (peripheral neuritis). If the internal popliteal nerve is involved, talipes calcaneo-valgus will ensue, whilst a lesion of the external popliteal nerve tends to produce talipes equino-varus. (*e*) Spastic contraction of one group of muscles as a consequence of deep spinal mischief of a sclerosing type occasionally leads to talipes of a spasmodic nature. (*f*) Shortening of the leg from hip or knee mischief may sometimes be the cause of a compensatory talipes equinus, whilst injuries or diseases of one of the epiphyses of the leg-bones may stop its growth, and then the continued development of the other bone forces the foot to one side or the other. (*g*) It is a question whether the condition known as flat-foot, arising from prolonged standing, is to be classed as a variety of talipes; some surgeons draw but little difference between it and talipes valgus. (*h*) Finally, prolonged maintenance of the foot in a bad position may lead to permanent deformity, as in the variety known as talipes decubitus. The barbarous custom still practised by the Chinese of forcibly compressing the feet of female children brings about a similar result.

Varieties.—In considering the different forms of club-foot, it must be remembered that the ankle is a hinge joint only allowing of flexion and extension, although when fully extended a little lateral mobility is also possible. The movements of abduction and adduction of the foot take place chiefly below the astragalus at the mid-tarsal articulation. Four primary varieties of talipes are hence described, viz.: **T. Equinus**, in which the heel is drawn up, the patient walking on the toes; **T. Calcaneus**, in which the toes are raised from the ground; **T. Varus**, in which the inner side of the foot is raised, the patient walking on the outer; and **T. Valgus**, due to eversion and drawing upwards of the outer side of the foot, or to yielding of the longitudinal arch on the inner side. Not unfrequently mixed forms occur, due to the association of two of the above, *e.g.*, T. equino-varus, or T. equino-valgus or T. calcaneo-valgus.

As to the *relative frequency* of these different forms, there is not the slightest question that T. equino-varus is by far the commonest. If, however, we exclude congenital cases and flat-foot, T. equinus is in all probability the variety most frequently observed.

Talipes Equinus (Fig. 214, A, B, and C) is almost always acquired: it has been known to occur congenitally, but this is exceedingly rare. It is usually due to paralysis of the extensor muscles, either from infantile palsy or injury to the anterior tibial nerve; secondary contraction of the calf muscles follows, the tendo Achillis being specially tense and rigid. It also occurs as a compensatory manifestation where the limb has been shortened, as after hip disease, and a variety known as T. decubitus results from the bed-clothes pressing for some length of time on the dorsum of the foot of a bed-ridden patient.

The heel is drawn up, and the patient walks on the heads of the metatarsal bones and on the toes, which are usually hyperextended. Occasionally, however, in neglected cases due to paralysis, the toes, instead of being extended, become flexed, the patient walking on their upper surface (Fig. 214, C); if such a condition is allowed to persist, the whole dorsum of the foot may in time be turned downwards. The astragalus is somewhat displaced from under the malleolar arch, only the posterior part of the articular surface being in contact with the tibia. This is more marked in the congenital and spastic cases than in those due to paralysis, where the deformity appears to result as much from a dropping of the anterior segment of the foot at the mid-tarsal joint as from flexion of the ankle. In all cases the sole of the foot is shortened by contraction of the plantar fascia, and of the short plantar muscles, a condition we shall shortly refer to under the name of pes cavus. In old-standing cases a certain amount of varus is almost always present. In this, as in all forms of talipes, bursæ form over points of pressure.

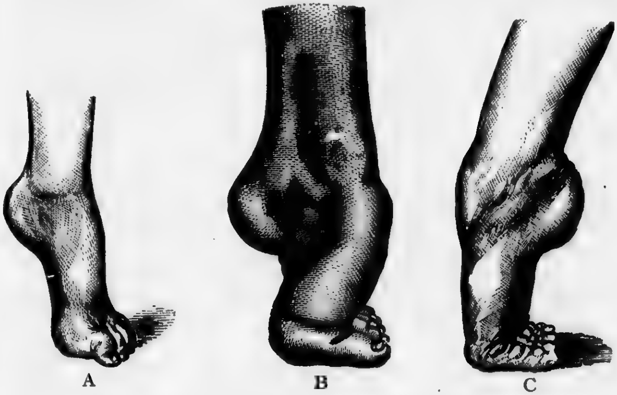

FIG. 214.—VARIOUS FORMS OF TALIPES EQUINUS.

Talipes Varus, or, as it is most commonly termed, **Equino-varus**, is the commonest variety of congenital club-foot, and is also not unfrequently acquired as a result of infantile palsy of the extensor and peroneal muscles, with secondary shortening of the tibialis anticus and posticus, the flexor longus digitorum, and of the tendo Achillis. Other cases are due to a primary spastic contraction of these muscles.

The heel is drawn up, and the anterior half of the foot adducted and drawn inwards (Fig. 215). The inner border of the foot is concave, and a well-marked transverse crease crosses the sole on a level with the mid-tarsal joint; the outer border becomes convex, and in adults who have walked a thick bursal formation is usually present over the cuboid. In neglected cases the patient may even stand on the dorsal aspect of the latter bone (Fig. 217, A). The sole of the foot becomes hollowed from secondary contraction of the plantar fascia and short muscles of the sole, especially the abductor hallucis, and a longitudinal crease may run down the centre of the sole, owing to doubling over of the outer metatarsal bones (Fig. 217, B).

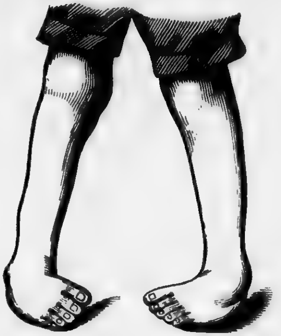

FIG. 215.—CONGENITAL TALIPES VARUS.

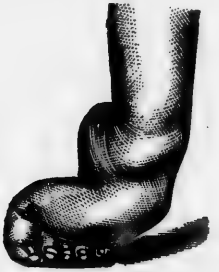

FIG. 216.—PARALYTIC FORM OF TALIPES EQUINO-VARUS.

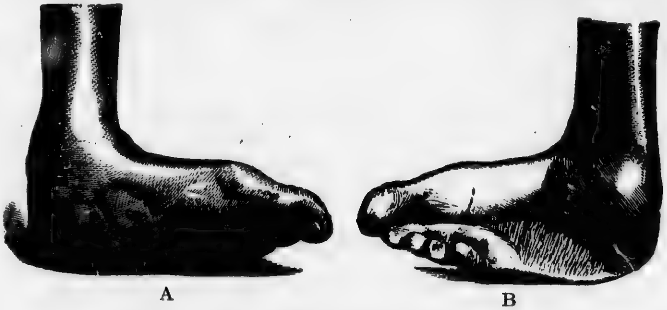

FIG. 217.—NEGLECTED CASE OF TALIPES VARUS.

The most marked **Anatomical Changes** are found in the astragalus. In infants the head and neck are normally set at an angle to the body of the bone, being directed slightly inwards; as, however, growth proceeds, this diminishes from about 35° to 10°, so that in the adult there is but little obliquity of the neck. In T. varus this angle is much increased, often amounting to 50° or more, the neck at the same time being longer than usual, a condition simulating that found in some of the higher apes. The bone is also projected forwards from under the tibio-fibular arch, the posterior portion of the upper articular facet alone remaining in contact with these bones. The scaphoid is displaced to the inner side of the head of the astragalus, so that only the inner portion of the latter structure articulates with it; the tuberosity is usually in close proximity to, or may even touch, the inner malleolus. The os calcis and other tarsal bones are also modified to some extent in position and shape to correspond with these changes. The dorsal tendons are displaced slightly inwards, usually occupying the centre of the concavity between the foot and the leg. The ligaments on the inner side of the foot are contracted, especially the anterior portion of the deltoid, the inferior calcaneo-scaphoid, and to a less extent the long and short plantar ligaments.

The following table (slightly modified from Mr. Tubby's excellent work on Deformities*) will suffice to indicate the chief diagnostic points between congenital and paralytic T. equino-varus:

	CONGENITAL.	PARALYTIC.
HISTORY.............	Affection has existed from birth.	Affection not developed till the second or third year, and ushered in by convulsions, fever, etc.
FEET AFFECTED	Usually bilateral.	More often unilateral.
CIRCULATION..........	Good.	Feeble; limb is cold, blue, and clammy.
MUSCLES	But little wasting.	Extreme wasting.
ELECTRICAL REACTIONS	Not much impaired.	Almost entirely absent in paralyzed muscles.
GROWTH OF BONES....	Much as usual.	Considerably diminished.
FURROWS IN SOLE	Present.	Absent.

The spastic variety is generally associated with spasm or contraction of other parts, which renders its nature obvious.

Talipes Calcaneus (Fig. 218) is an unusual variety of the deformity, and may be either congenital or acquired. In the *congenital* form the toes are drawn upwards, so that the heel alone comes into contact with the ground, the sole pointing forwards. The extensor tendons are all strongly contracted, but the toes may be flexed owing to the tension of the flexor longus digitorum. It is sometimes associated with deviation of the foot inwards or outwards, constituting a condition of T. calcaneo-varus or -valgus, as the case may be. The *acquired* variety is generally due to infantile palsy of the calf muscles, but occasionally results from over-stretching of the tendo Achillis after tenotomy. The longitudinal arch of the foot is here markedly increased, partly from the development of a large pad of fat over the calcaneal tuberosities, but mainly from the toes not being drawn up towards the leg as in the preceding variety. The anterior half of the foot appears to drop forwards from the mid-tarsal joint owing to secondary contraction of the plantar fascia and short muscles of the sole (Fig. 218).

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* Macmillan, 1896, p. 398.

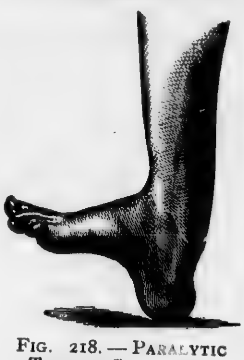
FIG. 218. — PARALYTIC TALIPES CALCANEUS.

Talipes Valgus is a condition seldom met with as a *congenital* deformity, except in association with T. equinus. In it the outer side of the foot is abducted and everted, owing to contraction of the peronei muscles. The sole becomes flattened, and the inner border of the foot comes in contact with the ground (Fig. 219). Considerable pain in the plantar region is usually complained of after walking a short distance. The scaphoid is displaced outwards, so that the inner portion of the head of the astragalus projects into the sole of the foot, the cartilage being uncovered. Occasionally this deformity is due to absence of the fibula. In the *acquired* variety, which is not uncommon (Fig. 220), a similar condition may be produced as a result of paralysis of the tibial muscles, or from spastic contraction of the peronei, the condition in these cases closely simulating the deformity known as flat-foot.

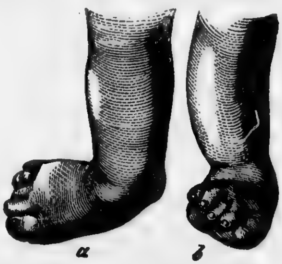

FIG. 219.—TALIPES VALGUS (CONGENITAL), WITH A LITTLE TENDENCY TO CALCANEUS.

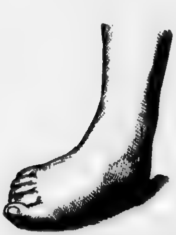
FIG. 220.—ACQUIRED TALIPES VALGUS.

The **Diagnosis** of the different varieties of talipes is, as a rule, easily made, although the cause of the deformity is not always so readily ascertained. In paralytic cases the limb is always atrophied, looking bluish in colour, and feeling cold and clammy. Various trophic lesions are not uncommon in the shape of recurrent ulceration, and even ulcers of the perforating type may develop, especially in those cases which are due to nerve lesions, whether central or peripheral.

The **Treatment** of talipes is always somewhat tedious, demanding care and patience on the part of all concerned. In the congenital variety no time should be lost in correcting the deformity, and, in fact, treatment should commence as soon after birth as possible. The nurse must be instructed to manipulate the limb into a good position, holding it there for some time daily. At the same time the muscles on the offending side of the limb should be rubbed and stimulated. In the early stages of the paralytic variety, friction and faradization of the paralyzed muscles must be regularly undertaken. At a somewhat later date treatment by the application of suitable mechanical apparatus may suffice to restore the foot to its normal position. If this is unsuccessful, division of the contracted tendons, ligaments, and fasciæ will be necessary, whilst in severe and neglected cases more extensive operations in the shape of tarsectomy or tarsotomy may have to be performed.

Talipes equinus, if secondary to hip disease, should not, as a rule, be interfered with. In other early cases, it may be remedied by what is known as Sayre's apparatus. This consists in the application of a plantar splint which projects some way beyond the toes, and from the anterior end of which a piece of adhesive strapping is carried to just below the knee, to which it is applied and fixed by a firm bandage. Each day the bandage is carried a little lower down the limb, and as the traction of the strapping is thereby increased, the foot is gradually extended. In the more serious varieties tenotomy of the tendo Achillis may be called for, accompanied, if need be, by division of the plantar fascia, whilst in neglected cases, or where tenotomy has failed, excision of the astragalus gives most excellent results, the patient being able to walk subsequently with a plantigrade foot.

Talipes equino-varus may be treated in the early stages by a modification of Sayre's apparatus, a strip of plaster being carried transversely round the splint, and drawn upwards on the outer side of the limb. A Scarpa's shoe with a double hinge action may also be employed. Another simple plan of treatment is to apply to the foot a carefully-fitted malleable splint, the shape of which is gradually altered so as to bring it in time to a normal position; or, again, a series of casings of plaster of Paris may be put on, a little improvement being obtained at each change. By care and patience many a cure will thus be obtained, but if time is of value, or if the improvement ceases, tenotomy is called for. The tibial tendons are usually divided first, and the tendo Achillis subsequently, although some surgeons, and especially Mr. Edmund Owen, recommend that the latter structure should always be first dealt with, as this will occasionally suffice alone.

The limb is at once restored to a good position, and put up in plaster of Paris. In the more marked cases division of the tense ligaments on the inner side of the foot (syndesmotomy) may be necessary, but especially of the anterior portion of the internal lateral ligament of the ankle-joint. The abductor hallucis muscle may also require section.

In neglected cases where the patient walks on the outer aspect of the foot, two chief forms of operative treatment have been advocated, viz., tarsectomy, and Phelps' operation. 1. In *tarsectomy*, a wedge-shaped portion of bone is removed from the outer aspect of the foot. This is accomplished through a transverse incision round the outer border on a level with the cuboid. The thick subcutaneous structures, including the bursa, are removed, and the tendons stripped up from the bones both on the dorsal and plantar aspects by the aid of a raspatory, and held aside by retractors. The extensor tendons are already displaced somewhat inwards, and hence are not injured by this proceeding. The tarsus is now divided by a chisel in two places in such a way that a wedge of bone can be removed, the base being on the outer aspect, and the apex on the inner. The position of the joints need not be taken into consideration, and as far as possible the sections should be made at right angles to the anterior and posterior segments of the foot respectively. The wound is now closed, and the foot placed in a good position, in which it is maintained by plaster of Paris. The after-treatment is likely to be prolonged, but otherwise the results are excellent, the foot, although a little shortened, being firm and plantigrade. 2. *Phelps' operation* consists in dividing all the structures on the inner aspect of the foot through a vertical incision, starting above just in front of the internal malleolus. Joints are, if need be, opened, tendons and ligaments divided, and the foot put up in a good position with the wound gaping. It is allowed to granulate, and healing may be accelerated by skin grafting. The results are at first quite as good as those attained by tarsectomy, and the operation has the advantage of not shortening the foot; but there is a decided tendency for the deformity to recur as cicatrization advances.

In *talipes calcaneus* all that is needed, as a rule, is the division of the extensor tendons; but in the paralytic variety some form of apparatus may always need to be worn. Where the tendo Achillis is thin and attenuated, a portion of it may be excised, and the ends united by suture, but the prognosis in all forms due to paralysis is somewhat unsatisfactory.

Talipes valgus, if unrelieved by the application of some form of Scarpa's shoe, may need division of the peroneal tendons, or in severer cases wrenching the foot into position, and fixation in plaster of Paris. Removal of a wedge-shaped portion of bone from the inner aspect of the foot may be undertaken, but is not very successful.

Flat-foot (*syn.:* **Splay-foot or Spurious Valgus**) is a condition frequently seen in young adults whose occupation exposes them to long standing, over-fatigue, or the carrying of heavy weights; hence it is commonly met with in nurse-girls and shop-boys who have only recently left school, any general deterioration of the health also assisting in the production of the deformity. It occurs as a natural condition in many of the negro races, and is more often seen in long than in short feet.

Mechanism.—As already stated, several different opinions are held by surgeons as to the primary causative factor in the production of this deformity, and many theories, which we need not even mention here, have been advanced. The most generally accepted idea is that it is in the majority of cases due to a relaxation of the inferior calcaneo-scaphoid ligament, which extends between the adjacent surfaces of the os calcis and scaphoid, supporting the under surface of the head of the astragalus, and thus keeping up the inner portion of the longitudinal arch of the foot. In its turn it is braced up by the tendon of the tibialis posticus and an expansion backwards therefrom to the os calcis, as also by the plantar fascia and ligaments and short muscles of the sole. When the weight of the body increases rapidly, and out of all proportion to the muscular development, this important ligament is likely to yield, and then the head of the astragalus is displaced downwards into the foot, causing obliteration of the instep. Possibly paresis, if not paralysis, of the tibialis anticus assists in this process, allowing the peronei tendons to abduct the front of the foot from the mid-tarsal joint, and in the later stages these tendons are often found tense and rigid. By the majority of authorities, this contraction of the peronei is considered to be secondary to the ligamentous lesion, and quite independent of any weakening of the tibial muscles. However produced, the *deformity* is tolerably characteristic (Fig. 221). The sole of the foot is flat, and in well-marked cases comes in contact with the ground throughout the whole of its extent. The inner border is convex and somewhat lengthened, whilst there is a tendency to eversion of its anterior portion: the outer border may be slightly raised from the ground. The head of the astragalus is distinctly felt a little in front of and below the internal malleolus, whilst the sustentaculum tali, which is normally to be distinguished about three-quarters of an inch below the malleolus, is buried by this displacement. The tubercle of the scaphoid is less evident than usual, being situated below and in front of the head of the astragalus. The gait becomes somewhat shuffling, and severe pain may be experienced, not only in the sole, but also in the bases of the metatarsal bones and in the toes. Sometimes it is extremely marked in the metatarso-phalangeal joint of the great toe, which may be enlarged and rigid, owing to an associated osteo-arthritis. The skin over the inner side of the foot is often thickened, whilst possibly on the outer side it is thinner than usual.

Treatment.—In the earliest stages, when the deformity, though threatening, has not yet actually developed, all that is required in many cases is rest, so as to allow the overstrained muscles and ligaments to recover themselves; at the same time the parts should be well rubbed with stimulating embrocations, and tonics administered to improve the general tone of the system. In the next stage, where the deformity, though present on standing, can be made to disappear by manipulation, or on making the patient stand on tiptoe, some slight support is advisable, and probably an indiarubber or cork instep pad worn inside the sock or stocking will be all that is necessary. In addition to this, square-toed boots must be used, so as to prevent any tendency to an increase in the valgoid position of the anterior segment of the foot. It is also wise to tell the patients to walk with the toes turned inwards, and in some cases assistance may be obtained by ordering them to sit cross-kneed in the tailor position, so as to exercise a certain amount of constant pressure inwards upon the feet. Regular exercises ought to be instituted, such as raising the body on tiptoe with the feet inverted; such can only be undertaken for a short time at first, but as the muscles regain their tone a longer period can be tolerated. In still worse cases a metal spring or instep-pad may be required; but frequently the tenderness of the sole is so great that it cannot be borne.

FIG. 221.—FLAT-FOOT.

When the affection has reached a later stage, and the deformity cannot be remedied by ordinary manipulation, forcible rectification under an anæsthetic may be employed. The foot is firmly grasped in the two hands, or in a Thomas's wrench, and the anterior portion is wrenched inwards and backwards in such a way as to force the scaphoid round the head of the astragalus as a fulcrum, and thus restore the arch. Probably a number of adhesions in the astragalo-scaphoid and other joints will be felt to give way during this manipulation. The foot is then put up in plaster of Paris and kept at rest for some weeks. The results of this method of treatment have been satisfactory.

In advanced cases that have been entirely neglected, operative proceedings are necessary, and probably the best of the many that have been suggested consists in removal of a wedge-shaped portion of bone from the inner side. Ogston advises that this should be taken from the neck of the astragalus, but others have advised either removal of the scaphoid or of a wedge-shaped section of the foot without respect to joints (Stokes).

Pes Cavus (Hollow or Claw Foot) is a condition characterized by increased concavity of the plantar arch, so that when the individual stands there is a greater interspace than usual, if not an absolute break, between the impressions produced by the anterior and posterior segments of the foot. It is almost always an acquired deformity, although a few cases of congenital cavus have been reported. Corresponding to the increased concavity in the sole, there is a marked convexity on the dorsal aspect of the foot, whilst the toes are almost always in the condition to be immediately described as hammer-toe, and the ball of the great toe is unduly prominent below. Considerable pain and inconvenience are occasioned by these associated deformities.

As to its **Causation** much has been written. Duchenne originally described it, maintaining that it arose from paralysis of the interossei and lumbricales in a manner similar to that which leads to the *main-en-griffe* after paralysis of the ulnar nerve, and it is quite possible that this accounts for a certain proportion of the cases. Others associate with it a slight degree of talipes equinus, and Parkin of Hull has worked out its method of production from this cause. The weight is normally carried to the ground mainly through the heel, but also partly through the toes; in these cases it is, however, only transmitted through the toes and front of the foot, and since the anterior exterior muscles are supposed to be weak and paretic, the short flexors are able to act at an advantage, and by contracting draw the heel downwards so as to reach the ground, and thus the arch is increased.

The **Treatment** in the early stages consists in friction applied to the weakened muscles of the leg, together, possibly, with the application of a splint to the sole. In very marked cases division of the tendo Achillis is needed, together with subcutaneous section of the tense plantar fascia. Attention must also be directed to the hammer-toes.

Hallux Valgus.—This condition consists in a displacement outwards of the great toe from the median line of the body, as a result of which the other toes are huddled together, and in extreme cases the hallux is placed over or under them (Fig. 222). It is present in the majority of people in some measure, owing to the usual shape in which boots are made; but in its severer forms it generally occurs in elderly people, and is often associated with osteo-arthritis of the metatarso-phalangeal joint of the great toe. From the fact that it is present in the poor almost as often as amongst rich people, it is evident that it cannot be due entirely to tight-fitting boots, the usually accepted cause. Some derangement of the muscles, resulting in excessive action of the powerful adductor group, must also be present. As a result, the cartilaginous surface of the head of the first metatarsal bone becomes exposed beneath the skin, and by the constant irritation of the boot it becomes inflamed, its structure and shape altered, and the joint more or less disorganized. Two other conditions are also met with arising from this deformity, viz., bunion and hammer-toe (*v. infra*).

A *bunion* consists in the formation of a bursa over the head of the first metatarsal bone, which becomes inflamed from cold or injury, and may even suppurate, the abscess usually communicating with the joint, and leading to its disorganization. A marked bony outgrowth is usually found under the bursa, springing from the inner side of the head of the bone, and due to a localized chronic periostitis.

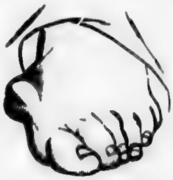

FIG. 222.—HALLUX VALGUS.

The **Treatment** of hallux valgus in its earliest stages consists in ordering correctly-shaped boots, with the inner border straight from toe to heel. In worse cases an apparatus may be worn, consisting of a band around the dorsum of the foot, to which is attached a support running along its inner border, towards which the great toe can be drawn by elastic tension. In the most severe types excision of the projecting head of the metatarsal bone through an incision made on its inner aspect, with replacement of the toe to a normal position, gives admirable results. Under no circumstances ought the second toe to be removed for this condition, as the lateral support of the great toe is thus weakened, and the deformity is very probably aggravated. An *inflamed bunion* is treated by removing all pressure, and applying warm fomentations. If the joint is involved by suppurative disease, excision of the head of the bone, or amputation of the toe, may be required. In less serious cases it may suffice merely to remove the thickened bursa.

Hammer-toe.—This deformity is constituted by hyperextension of the first phalanx, marked flexion to an acute angle of the second, and either flexion or extension of the terminal phalanx, so that the first interphalangeal joint projects under the upper leather of the boot, whilst the patient walks on the extremity of the ungual phalanx, or even on the nail (Fig. 223). Corns form upon the points of pressure (1, 2, and 3), especially on the dorsal aspect, and a subcutaneous bursa over the head of the first phalanx (4), giving rise to great pain and inconvenience. The second toe is that most frequently affected, with or without the others, but it is uncommon for the hallux to be thus deformed.

The **Causes** are numerous. It is occasionally congenital, but more often acquired, and then (*a*) it may be secondary to hallux valgus: (*b*) it may result from wearing short and pointed boots, or very high heels; in either case the toes are crowded together and drawn up out of the way of pressure: (*c*) it follows contraction of the plantar fascia, and is then associated with pes cavus (*q.v.*): (*d*) paralysis of the interossei and lumbricales may also lead to this condition.

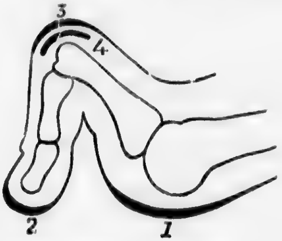

FIG. 223.—HAMMER-TOE. (AFTER KEEN AND WHITE.)

1, Callosity over head of metatarsal bone in sole; 2, callosity over end of toe; 3, callosity or corn over head of first phalanx; 4, adventitious bursa over the same bony point.

However caused, the hyperextension of the first phalanx is associated with a contracted state of the extensor tendons, which stand out very evidently beneath the skin. The flexion of the second phalanx on the first is carried to such a degree that the former bone is semi-dislocated. The prolongations of the plantar fascia on either side are much shortened, and the lower portions of the lateral ligaments of these articulations are also contracted.

Treatment may be commenced by the use of correctly-shaped boots, but, as a rule, the case has progressed to such an extent when the patient is first seen that no palliative measures are of any avail. Operation is then called for, and this may in the first place be directed to the contracted plantar fascia, if such be present, or to division of the lateral ligaments of the first interphalangeal articulation. Division of the extensor tendons may also be tried, but probably the displacement of the base of the second phalanx is such that nothing short of removal of the head of the first phalanx holds out any prospect of permanent relief. An incision is made longitudinally over the joint, the extensor tendon being split down the middle; the head of the bone is then cleared by the raspatory, and nipped off by cutting pliers. The foot is put up on a splint, and care taken to maintain the toes in a good position by the use of suitable appliances. There are, however, cases of hammer-toe affecting either the third or fourth digit that are perhaps best treated by amputation.

Metatarsalgia, or **Morton's Disease,** is characterized by severe pain of a neuralgic type located primarily about the head of one or more of the metatarsal bones, but also radiating thence up and down the limb. It often occurs in gouty or rheumatic subjects, and may be attributed to some form of injury; it is frequently associated with a slight degree of flat-foot, but may be due to the wearing of tight boots. Morton's explanation is that, as a result of the pressure of badly-fitting boots, the metatarsal bones and phalanges are laterally displaced, and the digital nerves compressed either between the third and fourth or between the fourth and fifth. That this displacement does occur in some cases has been recently demonstrated by skiagraphy, but it is doubtful whether the nerves are in reality compressed *between* the bones, as Morton believes. R. Jones, of Liverpool, has recently adduced some weighty reasons for believing that the pain is rather to be explained by compression of the nerves between the heads of the bones and the ground. In other cases a simple peripheral neuritis may explain the manifestations. The foot is usually found to be broader than usual, and marked callosities or corns are found on the under surface close to the heads of the bones, one or more of which may be unduly prominent. In a few cases small bony enlargements have been found projecting from the heads of the metatarsal bones. The pain is generally induced by walking, and comes on in characteristic paroxysms. Lateral pressure over the metatarsal bones sometimes relieves the pain. Occasionally evidences of osteo-arthritis are found in one of the neighbouring joints.

Treatment consists in allowing the foot to rest for some time, whilst suitable diet and drugs are ordered to combat any gouty or rheumatic tendency. At the end of a few weeks the patient may be allowed to walk again, but only with suitable boots, which should be broad anteriorly, and with an instep pad if flat-foot is present. Morton's recommendation—viz., excision of the head of the fourth metatarsal bone—may be reserved for the more aggravated and serious forms of the affection.

CHAPTER XXI.

THE SURGERY OF THE SCALP, CRANIUM, AND CRANIAL CONTENTS.

Diseases of the Scalp.

It would involve a needless amount of repetition to mention and describe in detail all the many conditions which may be met with in the hairy scalp, and therefore it is only necessary to deal with those which are of the greatest importance.

Suppuration is of common occurrence, arising mainly from septic infection from without, but being occasionally due to disease of the subjacent bones. The extent of the abscesses is limited by the same anatomical features as obtain in connection with hæmorrhage. Thus, a *subcutaneous* abscess is necessarily small in size, owing to the density of the tissues in which it is located; it arises most frequently as a result of eczema or impetigo, and is often due to the presence of pediculi, or to the action of irritants used in the cure of ringworm. A *subaponeurotic* abscess usually results from a septic penetrating wound, and is associated with cellulitis. A *subpericranial* abscess is rarely seen except in connection with disease of the bony calvarium; the pus is limited to the affected portion of bone.

Erysipelas is often seen in the scalp, either following septic wounds, or apparently arising spontaneously in individuals, in whom it reappears at more or less regular periods of the year. The disease is of the ordinary type (p. 97), but owing to the density of the scalp tissues the pain is extremely severe, and the swelling not very marked; the face and the eyelids, however, become puffy and œdematous to such a degree that the features may be almost obliterated. Abscesses may form subsequently in the loose tissue of the eyelids. Should the erysipelas be conjoined with septic cellulitis of the scalp, very grave symptoms may follow, owing to associated inflammation of the cranial bones and meninges, suppurative meningitis and pyæmia being perhaps the result. In the *treatment*, in addition to the measures ordinarily adopted, multiple scarification, of course stopping short of the aponeurosis, may be employed in order to relieve tension.

Cellulitis of the scalp usually arises from septic wounds which open up the so-called dangerous area—*i.e.*, the subaponeurotic cellular tissue. It is evidenced by all the local and general signs of this disease, described at p. 93, to which we must refer the reader. The pus tends to point at the most dependent spots, *i.e.*, along the line of attachment of the aponeurosis, and hence may 'bag' over the eyebrows, occipital protuberance, or mastoid process. The *complications* which may occur in the course of the disease are most serious: (*a*) Acute periostitis of the cranium (pericranitis), with sloughing of the pericranium and necrosis which may extend to a variable depth, but usually only involves the outer table; (*b*) infection of the diploe, with a septic inflammation spreading along the emissary veins, resulting in necrosis of the whole thickness of the bone, and possibly subcranial abscess and pyæmia;

(*c*) septic thrombosis of the intracranial venous sinuses, especially of the longitudinal and lateral, with pyæmic symptoms; (*d*) acute septic meningitis by extension from the sinuses; and (*e*) cerebral abscess from a similar cause. *Treatment* must be in accordance with general principles, free drainage and good nursing being mainly relied on. Necrosed bone will probably be absorbed, if superficial, with but little exfoliation; but if due to osteo-myelitis, larger portions may slowly separate. The treatment of the various complications is described under the appropriate headings.

A considerable variety of **Tumours** may occur in the scalp, which will be considered here according to whether they pulsate or not.

Pulsating Tumours of the Scalp may arise from three distinct sources:

I. They may be of *Extracranial* origin, and then are mainly associated with the superficial bloodvessels. (*a*) Ordinary *aneurisms* of traumatic origin are not uncommonly seen; they rarely attain any considerable size, and may be readily dealt with by excision. (*b*) *Arterio-venous wounds* may give rise either to an aneurismal varix or to a varicose aneurism. They usually involve the temporal trunk, and their symptoms and treatment require no special notice. (*c*) A curious dilated and tortuous condition of one of the scalp arteries, most often the temporal, is occasionally seen, and is known as an *arterial varix*. It may be treated by complete excision without any difficulty. (*d*) A *nævus* situated over the anterior fontanelle may derive a communicated impulse from the subjacent dura. It has no special features apart from this, and is to be treated in the same way as other nævi of the scalp, viz., by excision. (*e*) A much more serious and interesting phenomenon than any of the others is that known as a *cirsoid aneurism*.

Cirsoid Aneurism is more frequently met with in the scalp than elsewhere, and mainly involves the temporal region, but may also spread in all directions, even downwards into the neck. A tumour of greater or less size is seen under the skin, consisting of distended, tortuous, pulsating, bluish-looking vessels, the arteries opening directly into cavernous spaces without the intervention of capillaries; it is easily emptied by pressure, but quickly refills, owing to the abundant arterial supply. The rate of growth is variable, and the patient often complains of headache and giddiness; the skin becomes more and more thinned and atrophic, the hair falls out, and finally ulceration may occur, the patient probably dying from hæmorrhage. The **Treatment** is eminently unsatisfactory, complete excision being the only real cure, and this in the worst cases is totally impracticable. If it be attempted, the incisions should be made wide of the disease, and the supplying vessels secured, if possible, between double ligatures before dividing them; if this precaution is not adopted, frightful hæmorrhage may result. It is necessary in some cases to deal with the tumour in separate segments, allowing time between the operations for the patient to recover from the loss of blood. *Ligature of the common carotid* has been tried, and even both arteries have been tied in the same individual, with an interval between the operations, but with little benefit. *Ligature of the main arteries feeding the tumour*, combined with incisions around it and between the vessels down to the bone, has been successful in a few recorded cases. *Division of the mass by the galvano-cautery* has also been recommended, the wire being passed in separate directions on different occasions, and thus the mass is broken up into segments which can be more easily dealt with. Such a proceeding is, however, objectionable, since secondary hæmorrhage is very likely to occur when the sloughs separate. Probably *electrolysis*, combined with ligature of the main nutrient vessels, holds out the best chance of success. (For methods of electrolysis, see p. 301.)

II. The chief pulsating tumours of *Cranial* origin are as follows: (*a*) Sarcomata arising from beneath the pericranium or from the diploe (*vide infra*). (*b*) Secondary nodules of cancer may develop in the diploic tissue; those due to the form known as thyroid cancer are specially noted for their pulsation. (*c*) Aneurism by anastomosis is occasionally seen in the cancellous tissue of the diploe, and gives rise to pulsation when the bones are sufficiently expanded and atrophied to allow of it (p. 554).

III. Pulsating swellings of *Intracranial* origin include the following conditions: Meningocele and encephalocele (*vide infra*); traumatic cephal-hydrocele (p. 461); hernia cerebri (p. 496); and sarcoma of the dura mater (p. 647).

Solid Non-pulsating Tumours of the Scalp.—Almost any of the ordinary connective tissue or epithelial growths may occur, but the following are the more important:

Papillomata are not uncommon in the form of little hard warty outgrowths, giving rise to but little inconvenience, unless situated on some spot where the hat rests. They are easily removed, and it is advisable to touch the base with nitrate of silver.

Epithelioma also occurs, arising either from an irritated papilloma, or possibly in connection with a sebaceous cyst. As soon as a diagnosis is made, the growth should, if possible, be extirpated, and the resulting raw surface may either be left to granulate, or dealt with by Thiersch's method of skin grafting.

Fibroma is also seen either in the shape of a localized development of hard fibrous tissue, and often growing on the forehead where the hat crosses it; or it may attain much larger dimensions, involving perhaps half the scalp, and giving rise to an irregular nodulated outgrowth of fibro-cellular tissue, which has sometimes been termed a *pachydermatocele*. Either form may be dealt with by excision.

Dermoid Cysts are by no means uncommon in this region, their favourite situation being near the outer canthus, the temple, or the root of the nose. For a general description, see p. 164. They do not, as a rule, attain any great size, and may not become evident till after puberty. The underlying bone is often hollowed out from a defective development of the mesoblastic tissues around them; and a congenital opening may even exist through which a narrow neck passes, bringing the cyst into direct union with the dura mater. The *treatment* consists in removal; but it is advisable to delay this till after puberty if the tumour seems at all fixed to the skull, or if the bone is felt to be defective beneath it, as in such cases the communication with the interior of the cranium often becomes shut off by that time.

Sebaceous Cysts (p. 168) find their most usual situation in the scalp, where they not only are frequently multiple, but also may reach a considerable size. Their removal is best accomplished by transfixion, squeezing out their contents, and picking out their cyst wall with a pair of forceps without dissection. The wound is closed by one or two stitches.

Affections of the Skull.

I. **Congenital Affections.**

1. **Meningocele, Encephalocele,** and **Hydrencephalocele** consist of a protrusion of the dura mater, with or without part of the brain, through an opening in the cranial wall, due either to defective development of the bones or to the non-closure of one of the sutures. They occur most frequently at the root of the nose, and in the occipital region (Fig. 224), occasionally at the anterior or one of the lateral fontanelles, or at the base of the skull. A *Meningocele* is simply a protrusion of the brain membranes containing cerebro-spinal fluid. It forms a soft, rounded, fluctuating swelling, attached to the skull by a base of greater or less size, and covered by skin, which may be thick and healthy, or thinned, bluish, and translucent when the tumour is large. The vessels present in the skin are often dilated and nævoid. It increases in size and tension on any expiratory effort, such as coughing or crying, and it may be partially reducible, thus allowing the margins of the opening in the cranium to be defined. Symptoms of cerebral compression, convulsions, etc., are likely to be produced by such manipulation. An *Encephalocele* is a similar type of tumour, but contains brain substance, and pulsates nearly synchronously with the heart; it is most commonly situated at the back of the skull. A *Hydrencephalocele*, or Meningo-

encephalocele, is a condition in which the tumour contains both brain substance and fluid. Two varieties have been described, one in which there is a small protrusion of the brain associated with an ordinary meningocele, and the other in which the fluid is contained in a cavity communicating with one of the ventricles, and covered by a thin layer of brain substance. They are usually of considerable size, and situated in the occipital region, either above the tentorium, and then associated possibly with distension of the posterior cornu of one of the lateral ventricles, or below that structure, the osseous defect extending in some cases as far as the foramen magnum, and a portion of the cerebellum being within the sac.

The **Prognosis** of these conditions is exceedingly grave. Fortunately, many of the subjects are born dead, or die soon after birth. In the more severe cases, idiocy and microcephaly are not uncommonly associated. The tumours may either increase steadily in size, whilst the skin becomes ulcerated, and may finally burst, causing death by purulent meningitis, or they may remain stationary. In a few limited forms of meningocele, the subsequent growth of the cranial bones may suffice to close the communication between the interior and the tumour, which thus becomes shut off, and remains as a cyst-like swelling, with the base fixed, and without pulsation or respiratory impulse.

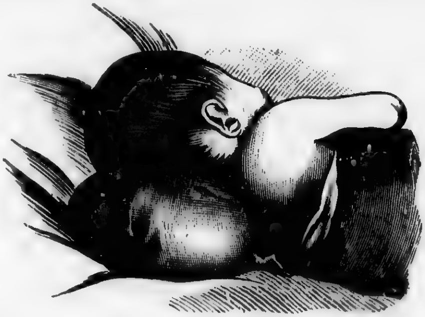

FIG. 224.—CONGENITAL ENCEPHALOCELE OF THE OCCIPITAL REGION. (TILLMANNS.)

Treatment.—Where possible, the patients should be left alone; but when the tumour is steadily increasing in size, antiseptic puncture and subsequent compression may hinder the process; a pure meningocele may possibly be cured in this way. Where the communication with the skull is small, it may be feasible to totally excise the tumour, taking special care to securely suture the base, and attempting when practicable to make good the cranial deficiency by osteoplasty.

2. In infants the ossification of the bones may be incomplete, constituting what is known as *aplasia cranii congenita*. This may be localized, occurring in patches scattered here and there, or may extend over the whole cranium, especially affecting the frontal bone and the region of the sagittal suture. A thin layer of bony material may subsequently be laid down in an irregular manner, so that if complete ossification follows an unusual number of sutures may be seen. The cause of this affection is said to be fœtal rickets, arising from a cachectic condition of the mother. A similar condition has been artificially produced in puppies by removing the thyroid body from a bitch during pregnancy. Great care will be needed in dieting such children and protecting them from injury. Occasionally a similar atrophic condition of the bones may persist through life, exposing the patient to great risks from injuries which otherwise would do but little harm.

3. Localized congenital atrophy of the bones is also sometimes met with in connection with dermoid cysts, as mentioned above.

II. **Acquired Affections** of the skull are atrophic, hypertrophic, inflammatory, or neoplastic in nature.

Acquired atrophy of the skull occurs in many forms:

(*a*) *Cranio-tabes* is a condition met with during the first year of life, as a result both of rickets and of inherited syphilis, though more frequently the former. Portions of the occipital and parietal bones become soft, and on digital pressure yield with a sensation like that derived from stiff parchment. There is in most cases a total absence of bony tissue at the spot.

(*b*) *Senile* atrophy may affect the whole cranium, which becomes thinned and rarefied, the change commencing from without, a similar condition occurring also in the jaws from the loss of teeth, and subsequent absorption of the alveoli; or it may be localized, as pointed out by the late Sir G. M. Humphry,* to the parietal bones, constituting hollow depressions which extend antero-posteriorly. No symptoms are caused thereby, but the patient runs a certain increased risk from injuries to the head.

(*c*) Localized loss of substance may result from the pressure of tumours, such as Pacchionian bodies, aneurisms, necrosis, or traumatic and operative lesions. If these are at all extensive, the cerebral pulsations can be felt distinctly through the skin. It is then advisable to provide the patient with some guard to protect him from the risk of injury. This may be accomplished by means of a metal plate worn over the scalp; but where the lesion is due to injury or operation, surgeons have of late years been endeavouring to remedy the defect in a more satisfactory manner by operation. *Autoplasty* is the term applied to a proceeding whereby the defect is closed by a plate of bone removed from the patient's own skull. A suitable scalp flap is turned down, and then a portion of the outer table is chiselled up sufficient in size to close the aperture. The pericranium is utilized on one side as a pedicle, and by means of this it is stitched down into the gap, the margins of which have been previously freshened. By *heteroplasty* is meant a similar proceeding when the hole is closed by a plate of gold, platinum, or vulcanite let in under the pericranium or inserted between the dura mater and the cranium. The results of these procedures have been on the whole encouraging.

(*d*) *Hydrocephalus* is always associated with atrophy and thinning of the cranium. It may be congenital, or may commence early in life, but is always a chronic condition. (The so-called acute hydrocephalus is in reality tubercular meningitis.) It is produced in almost all cases by a distension of the lateral ventricles with fluid, the result of congenital malformation, or of inflammatory affections, causing exudation from the choroid plexuses, pressure upon the veins of Galen or inferior longitudinal sinus, and possibly closure of the foramen of Majendie. The head becomes more and more distended, the bones expanded and thinned, and the sutural areas increased, whilst the brain is subjected to such pressure as may be incompatible with life. Fluctuation is distinctly felt, and the bones may crackle under the fingers; the face looks abnormally small, and the eyes protrude, owing to the depression of the orbital plates. *Treatment* is usually hopeless. The ventricles may be tapped at a spot some little distance from the median line, and a considerable amount of the fluid withdrawn, whilst elastic pressure is subsequently maintained; but as the cause cannot be dealt with, recurrence is almost inevitable.

(*e*) By *microcephaly* is meant a condition of diminished size of the cranial cavity due to premature ossification of the sutures. It is usually associated with idiocy, and possibly with the cretinoid variety. Of late years attempts have been made to relieve this by the operation of linear craniectomy or removal of portions of the cranium, so as to allow of the expansion of the brain. A broad strip of bone is excised on either side of the median line, from back to front, and sometimes another transversely. A small trephine aperture is first made, and then the opening is prolonged antero-posteriorly by a circular saw driven by electricity, or by a Hey's saw, or by a bone rongeur. The two sides of the skull are usually dealt with at separate times. Temporary improvement has followed in many cases; but the final result has now been shown to be extremely uncertain, the majority of the patients relapsing owing to the contraction of the dense cicatricial material which replaces the removed bone. The proceeding cannot be looked on as more than a justifiable experiment.

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* Med.-Chir. Trans., 1890, p. 327.

Hypertrophic Changes of the Skull may result from simple chronic inflammatory affections, or from injury, etc., or they may take on special forms in some diseases.

(*a*) In *inherited syphilis* overgrowth of the bones occurs usually around the margins of the anterior fontanelle, constituting what are known as 'Parrot's nodes.' The depression of the fontanelle is noticed in the centre of the newly-formed tissue, so that the mass feels somewhat like a hot cross-bun. On post-mortem examination the bone in the early stages is found to be soft, spongy, and congested, the cancelli running at right angles to the subjacent surface; later on the tissues become condensed, and only a slight sutural depression occurs in the centre. No special treatment is called for.

(*b*) In *rickets* the shape of the head is frequently modified, the cranium being either compressed antero-posteriorly or, in rarer instances, from side to side. In the former the forehead is high and prominent, and both frontal and parietal eminences are enlarged, owing to a new formation of soft bone from under the periosteum. Occasionally the whole cranial convexity is involved in a similar process. In addition to these changes, the fontanelles usually close late, and the dentition is delayed and defective (p. 541).

(*c*) In *osteitis deformans* the cranium gradually increases in size and thickness from without (eccentric), so that the patient continually requires larger hats. The facial bones are not, as a rule, much affected. For fuller particulars, see p. 546.

(*d*) In *acromegaly* there is overgrowth of the facial bones rather than of the cranium, the superciliary ridges projecting, and the upper and lower jaws prominent and hypertrophied, so that the whole face becomes elongated and oval (p. 548).

(*e*) *Leontiasis ossea* is a rare condition usually affecting young people, characterized by a diffuse overgrowth of the bones of the skull and face, the latter being, as a rule, the more marked. The cranium becomes thickened concentrically, the new bone in time encroaching on the brain (p. 670).

Inflammatory Affections of the Cranial Bones.—The cranium is liable to any of the diseases which generally occur in bone, the more important of which are:

1. **Acute Periostitis, or Pericranitis**, which is usually septic in origin, and arises as a complication following cellulitis of the scalp; it is likely to result in necrosis of the outer table.

2. **Acute Infective Osteo-myelitis**, or acute necrosis, consists of an acute inflammation of the diploe, due to the *Staphylococcus pyogenes aureus*, and either following a septic scalp wound or a contusion of the bone in a person of low germicidal powers. The symptoms and signs are those generally characteristic of the disease, the pericranium being stripped up by diffuse suppuration beneath it, and abscesses opening in many situations. Necrosis of the whole thickness of the skull is likely to follow, whilst pyæmia or extension of the inflammation to the membranes, venous sinuses or brain are the chief dangers arising from it. The *treatment* consists in free external drainage; but in addition it may be necessary to remove the outer table of bone with chisel and mallet, and to thoroughly scrape away all the the septic diploe, disinfecting the parts beneath with pure carbolic acid.

3. **Chronic Periostitis** of the cranium is occasionally met with in the form of nodes. It is usually the result of some long-continued irritation, such as carrying baskets or weights on the head. Thus, a Billingsgate fish-porter developed

an adventitious bursa upon his vertex, and when this became inflamed a periosteal node formed beneath it. *Treatment* consists in the removal of the irritation, and there is no objection to chiselling away the node, if necessary.

4. **Tubercular Disease** of the cranial bones is met with either as a primary phenomenon or as a secondary result of cutaneous lupus or tuberculosis. It may be periosteal in origin, or may start in the diploe, causing expansion of the bone and the formation of a node. It runs a typical course, and requires the usual treatment. It is a very unusual form of disease.

5. **Syphilitic Disease** of the cranium, on the other hand, is exceedingly common, occurring usually in the tertiary stage, and affecting most frequently the frontal and parietal bones. It may manifest itself in various ways, which have been already described (p. 538).

Tumours of the Cranial Bones.—The chief **Tumours** affecting the calvarium are osteomata and sarcomata.

Osteoma of the cranium occurs as a localized overgrowth either of cancellous or of compact bone, more commonly the latter. It grows from the outer surface of the bone, from the inner, or from both. If arising externally, a smooth, rounded, globular swelling is produced, hard to the touch, quite painless, and attached to the subjacent bone by broad bases; more than one may be present. If the main development is internal, the early symptoms will depend on their situation, as to whether evident functional disturbance of the cortex will be produced; when very large, they give rise to compression of the brain, and possibly optic neuritis. They are to be distinguished from inflammatory hyperostoses (usually of syphilitic origin) by their sharp limitation, absence of pain, and slower progress; whilst osteo-sarcomata are commonly rapid in growth, painful, and of unequal consistency in different parts. *Treatment* is rarely called for in those developing inside the skull except when cerebral symptoms are produced; and since they are rarely diagnosed in the early stages, except when the tumours are situated over the motor area, the disease has usually progressed too far before coming under observation to permit of their safe removal. If they can be localized, a trephine opening is made over them, and as much removed as is practicable. The external tumours may be chiselled away freely, but it must not be forgotten that cerebral concussion may follow the prolonged use of the chisel and mallet against the skull.

Sarcoma of the cranium may arise either from the pericranium, the diploe, or from the dura mater.

The *extra-* or *peri-cranial* variety consists of a round or spindle celled tumour growing from the pericranium, and possibly attaining a considerable size. There may be a certain amount of ossific deposit within it, or the tumour may remain of a soft consistency, and then often pulsates. The subjacent bone may be absorbed, and the dura mater affected secondarily. General infection of the system follows.

Central sarcoma of the cranium starts from the diploe as a myeloid tumour. It does not grow so rapidly as the other forms; it is single, and generally covered with a layer of expanded bone, which gives a sensation of eggshell crackling to the finger. Later on it involves the dura mater and skin, and may fungate externally.

Sarcoma of the dura mater may be attributed to some injury to the head, and is characterized by the occurrence of severe cerebral symptoms, *e.g.*, intolerable localized headache, epileptic fits, double vision, optic neuritis, etc., prior to any evident appearance of a tumour. Gradually the bones become perforated and expanded, and a pulsating growth is felt beneath the scalp, which is soft and exceedingly vascular. This sooner or later fungates, and possibly the meningeal cavity may be laid open by ulceration, death from septic meningitis, cerebral compression, or exhaustion ending the chapter. General infection of the system is also often present.

Treatment of these cases is almost impossible, since they are almost certain to have gone too far before being recognised. If an early diagnosis can be arrived at, free removal by trephining and the chisel may be undertaken.

Affections of the Frontal Sinuses.

These sinuses are cavities in the frontal bones lined with a mucous membrane continuous with that of the nose. They can hardly be said to exist in children, not developing much before the age of twenty. In adults they vary much in size, but the prominence of the superciliary ridges is no guide to their extent.

Fracture of the anterior wall is not uncommon as the result of a direct blow, depression of the fragments being produced, but without cerebral complications. If the mucous membrane is torn, surgical emphysema of the scalp and face may follow, and is naturally increased on blowing the nose. In such compound fractures, suppuration within the frontal sinuses may lead to necrosis, and if there is an associated wound of the deeper wall, the contents of the cranium may be involved. In rare cases, where necrosis and loss of substance of the anterior wall has occurred, a localized collection of air may form under the skin, and remain as a permanent tumour, constituting what is known as a *pneumatocele capitis;* it rises and falls with forced respirations. A similar condition may also result from a fracture into the mastoid cells; in either situation it should be treated by compression, or, failing this, incision.

Inflammation of the frontal sinus may be caused by extension of catarrh from the nose, by penetrating wounds or fractures, by foreign bodies, or may be secondary to disease of neighbouring bones. But little effect is produced, unless the infundibulum becomes blocked, and then *distension* of the sinus is produced. If occupied by mucus (*hydrops*), a slowly-forming tumour is noticed without much pain or discomfort, but the bony walls gradually become thinned, and may give a sensation as of 'eggshell crackling.' If distended with pus (*empyema*), similar symptoms result, but there is concurrent inflammatory disturbance and pain in the neighbourhood. Occasionally extension of mischief to the cavernous or other venous sinuses may follow. The case must be treated by laying the cavity open and draining it. For this purpose a curved incision is made along or immediately below the eyebrow, and the soft parts stripped from the bone, which is trephined or punctured with a gouge, according to its thickness, close to the middle line; the pus or mucus is removed, and the passage into the nose explored and dilated so as to allow of free drainage. The cavity is syringed out for some days, and the wound usually closes readily, although a fistula may occasionally remain. Some authorities recommend a median vertical incision, and this is especially useful if there is any doubt as to which sinus is involved, or if both are affected.

The chief **Tumours** growing from the frontal sinuses are mucous cysts or polypi, and ivory osteomata; they may also be involved in diffuse sarcoma or carcinoma, but the disease is then not limited to the sinus. The main symptoms and signs result from distension of the walls of the cavity, which may yield anteriorly, causing a large frontal swelling, or the posterior wall may project and be absorbed, leading to cerebral compression, or the upper wall of the orbit may be depressed, causing dislocation of the eyeball, and possibly blindness (Fig. 35). Tumours which have attained considerable dimensions can rarely be removed, death then resulting from cerebral compression; but occasionally bony masses may necrose, and become loosened by suppuration around them, and in a few cases they have been taken away successfully.

Cerebral Tumours.

The diagnosis and treatment of cerebral tumours is entirely the outcome of the experimental work of recent years, inaugurated by Fritsch and Hitzig, and elaborated by Ferrier and others, who have thereby demonstrated that different parts of the brain have specific functions, and that definite focal symptoms may result from injuries of special areas.

The chief **Varieties** of new growth met with in the brain are as follows: (i.) *Glioma*, or glio-sarcoma, which consists of a small round-celled neoplasm with a very delicate intercellular substance, similar in character to the neuroglia; it may occur in any part of the brain. It is always continuous with the surrounding cerebral tissue, and is scarcely ever encapsuled, so that, on naked-eye appearance, it may be indistinguishable from brain substance, although rather harder, and hence its limits can seldom be accurately defined. (ii.) *True sarcomata* also occur, and occasionally secondary carcinomatous deposits. (iii.) *Tubercular foci* are met with apart from any meningeal infiltration, varying in size considerably, and may be either firm and caseous, or with a diffluent centre. (iv.) *Gummata* of the brain usually spring from the meninges, and are more irregular in shape than tubercular masses. (v.) Occasionally *hydatid cysts* are found, as also other less common conditions.

The **Symptoms** of a cerebral tumour may be classified as follows: (1) Those due to increased intracranial pressure, such as fixed headache, giddiness, epilepsy, loss of memory, and stupor, finally ending in coma. The headache varies much in character, but is usually localized, and is often associated with tenderness on deep pressure over the scalp. Occasionally the coma and fatal issue supervene suddenly as a result of acute spreading œdema (p. 489). (2) Vomiting and constipation are also very marked phenomena, associated with loss of appetite and great emaciation. The temperature is usually subnormal, but if there is any basal meningitis it may be elevated. (3) Optic neuritis is generally present, and is supposed to be due either to the increased intracranial pressure, causing obstruction to the return of blood from the eye to the cavernous sinus, or to a descending neuritis, or possibly to both. In the early stages, the clear definition of the disc margin becomes obscured, and the retinal veins congested and tortuous; the retina is œdematous, so that the vessels are only seen at intervals, and linear ecchymoses may also occur. If the patient lives long enough, atrophy of the disc follows. In the early stages vision may be but little affected, but, as a rule, it is considerably impaired as the case proceeds. In some cases this condition may be more marked on the side of the lesion, but is generally bilateral. (4) Focal symptoms are only produced when some area of the brain with definite functions is involved. Irritative phenomena manifest themselves first; paralytic symptoms occur later on. We must refer students to what has already been stated in Chapter XVI. and to larger text-books of medicine, for a full consideration of these phenomena. The surgeon is seldom called upon to make a diagnosis in these cases, and therefore the full details of this intricate subject will not be considered here.

Treatment.—In every case, the possibility of the symptoms being due to gummatous disease must not be forgotten, and large and increasing doses of iodide of potassium (even up to 40 or 60 grains three or four times a day) should be administered before undertaking operative proceedings. Symptoms of gastric irritation must be prevented by giving some alkaline carbonate (especially the ammonium or soda salts), whilst the dose must be freely diluted with water.

Operation.—It is most desirable that this should be undertaken as early as possible, since, even if it is proved that no tumour exists, the patient runs no serious risk, whilst delay until all the symptoms are well marked may prevent the total removal of the growth. Occasionally it is divided into two stages, one consisting in the removal of the bone, and the other, six or eight days later, involving the intracranial portion; but such a modification is not essential, and is sometimes undesirable.

The scalp should be entirely shaved a day or two previously, and very thoroughly purified. A quarter of a grain of morphia is injected about half an hour before the operation, with the idea both of reducing the vascularity of the brain and of dulling the patient's sensations, so that a smaller amount of anæsthetic is subsequently needed. Chloroform should be employed rather than ether, as it produces less congestion of the head. The surgeon marks the spot selected for the application of the trephine by drilling the bone with a bradawl through the scalp. A large semicircular flap is then turned down, exposing a considerable area of the calvarium, so that if a larger amount of bone than is expected needs to be removed, no fresh scalp incisions are required; moreover, the cicatrix will in this way be prevented from forming over the trephine opening. A crucial incision is made through the pericranium, which is retracted to a sufficient extent to allow a 2-inch trephine to be applied, the centre-pin being placed in the hole previously made by the bradawl. A Galt's trephine (*i.e.*, an instrument with shelving borders) is to be preferred to one of the ordinary type. The disc of bone is carefully removed, and placed in warm and sterilized normal saline solution, so that it may be subsequently replaced if necessary. Other methods of removing the calvarium have been introduced, so as to enable the surgeon to denude a considerable area of the brain. Thus, the bone may be partially sawn through in such a way as to divide the portion to be removed into rectangular areas; then if the whole thickness of the bone is removed at one spot by a trephine, it is easy to cut away the remainder with bone pliers. Other surgeons prefer Wagner's method, which consists in turning down a flap of skull with the soft parts. After the superficial incision has been made, the bone is divided along the same line, either by a circular saw driven by electricity, or by one of the ingenious surgical engines—more or less resembling a dental drill—which have been recently introduced. The base of the flap is broken through by prising the upper portion outwards. It is for such severe measures as these that the operation in two stages is recommended.

The dura mater thus exposed is firm, but yields slightly to the finger, and allows the pulsation of the subjacent brain to be felt, if the latter is healthy and no undue pressure is present within; but if the intracranial tension is markedly increased, the dura mater bulges into the wound, feels firm and unresisting, and the cerebral pulsations are diminished or absent.

The dura mater is next incised crucially, or a flap turned down, care being taken of the meningeal vessels; the brain substance will protrude if the intracranial pressure is abnormally increased. The region is now carefully explored by the finger, and any areas of abnormal hardness or softening noticed; failing this, a grooved needle is inserted in different directions, or a fine trocar and cannula. In introducing such instruments, care must be taken only to make direct stabs, and never any lateral movements, which necessarily lead to laceration of the brain. The opening of the skull may be enlarged, if need be, either by the use of the bone rongeur or by additional small trephine openings. It is but rarely that a cerebral tumour is so placed that enucleation is possible. If, however, a cortical neoplasm is found, it is isolated from the surrounding brain substance by blunt instruments, *e.g.*, the handle of a scalpel, or a flexible knife, made of platinum, as suggested by Horsley, and the mass freely removed. Hæmorrhage is controlled by the application of a fine ligature, or by the use of serre-fines or sponge-pressure. The dura mater is then loosely stitched together, and a drain-tube inserted, reaching to the bottom of the wound, and brought out at one angle of the incision in the skin, which may be closed by a continuous suture. If the tumour has been satisfactorily enucleated, the disc of bone may be placed *in situ*, room, however, being left for the passage of the drainage-tube; but if there is any doubt as to its complete removal, the opening in the bone is left. After the operation, the patient must be kept absolutely quiet, with the head slightly raised. The drainage-tube may be removed in twenty-four or forty-eight hours, and the scalp wound is usually healed in six or seven days.

Even if the tumour is inaccessible or irremovable, temporary benefit will result from an exploratory operation, since a subcutaneous hernia cerebri is thereby allowed to form, and intracranial tension relieved, as evidenced by an improved mental condition and loss of pain; as the tumour grows, however, the patient relapses into his former state, and death sooner or later follows.

Abscess of the Brain.

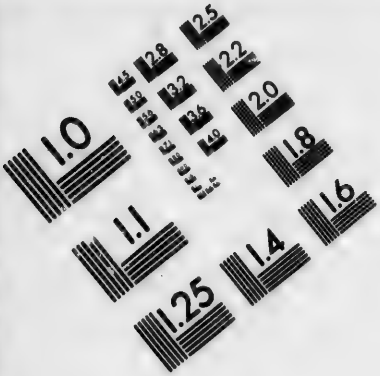
Causes.—The most frequent source of cerebral abscess is chronic disease of the middle ear, and Barker states that fully 50 per cent. of all cases arise from this cause. They usually run a somewhat chronic course, but may suddenly give rise to symptoms of acute coma, either by bursting into one of the lateral ventricles or by the supervention of a spreading œdema. A certain percentage of cases is also due to traumatism, either immediately or remotely; in the former the symptoms are acute, and probably result from a penetrating wound, whilst in the latter instance they are more chronic, and may not supervene for months. Tubercle and pyæmia are also responsible for a few cases of cerebral abscess.

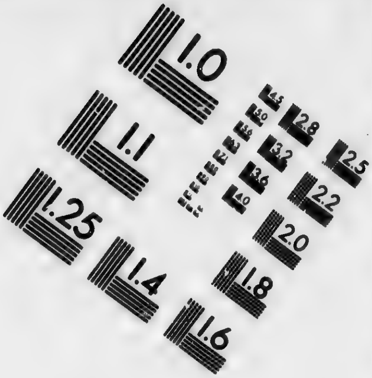
The **Symptoms** vary somewhat with the method of onset and the characters of the abscess. If traumatic, and due to infection from without, the case runs an acute course, associated with intense pain in the head, recurrent rigors, and rapid development of coma. General meningitis is often present, and the two conditions can scarcely be distinguished.

When the case is subacute or chronic, the symptoms are more characteristic, and may be grouped together under the following three heads: (1) Those resulting from the presence of pus within the body. These are, however, not typical, since, although there may be an initial rigor, the temperature is, as a rule, normal or subnormal, unless basal meningitis co-exists. (2) Those resulting from intracranial pressure and irritation. Pain in the head is usually the earliest and most marked of these; at first it is often general, but later on becomes fixed, and localized to the seat of the abscess. It varies greatly in amount, sometimes being of the most agonizing type, sometimes very slight; it is usually continuous, but may be intermittent, and entirely disappear for a time. Anorexia, malaise, vomiting, and constipation are often present; the pulse is usually slow and intermittent, and Cheyne-Stokes respiration may occur in the later stages. Epileptic seizures may also be induced, and the patient passes into a state of mental torpor, and even coma. Optic neuritis, more marked on the affected side, is another symptom, and the pupil on that side is dilated and does not react to light. (3) Focal phenomena arise as in cases of cerebral tumour. The chief facts in connection with cerebral localization have been discussed at p. 493, and the special features of abscess in the temporo-sphenoidal lobe or in the cerebellum are described at p. 746. If unrelieved, the patient dies in a state of coma, from interference with the vital centres in the medulla.

Diagnosis.—From *meningitis*, a cerebral abscess is usually recognised by the fact that in the former condition irritative phenomena, such as acute and active delirium, contraction of the pupil, photophobia, rigidity and spasm of muscles, especially in the back of the neck, and severe pain, are more evident and are produced earlier. The temperature is usually high, and mental dulness comes on within three or four days, whereas an abscess rarely forms before the end of the first week. *Extradural abscess* (subcranial) is associated with a high temperature, earlier onset after an injury in traumatic cases, and more rapid compression symptoms; optic neuritis is only occasionally met with, and the vomiting is less troublesome. There is also likely to be some localized œdema or tenderness on deep pressure. For the diagnosis from *mastoid disease* and from *lateral sinus pyæmia*, see Chapter XXV. It is often impossible to diagnose between a chronic abscess and a *tumour of the brain;* the symptoms in the latter may, however, come on more slowly than in the former, whilst the temperature remains near the normal. The history of the case may throw some light upon its nature, but an exploratory operation may be necessary to clear it up. Tumour is more common in the frontal and parietal regions, abscess in the temporo-sphenoidal lobe. Optic neuritis is more marked in tumour than in abscess.

Treatment.—The suspected area of the brain must be exposed and explored as for a cerebral tumour, and when the presence of pus has been ascertained, a delicate pair of sinus forceps may be passed along a grooved needle, and by opening them the pus is evacuated. The cavity, which is rarely large, is gently washed out, and a drainage-tube inserted; this should be kept in for a few days, but not longer than is absolutely necessary, for fear of a hernia cerebri being induced thereby.





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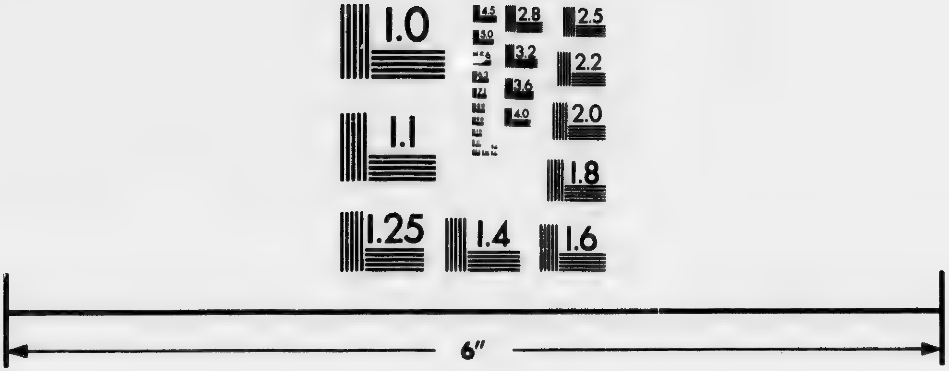

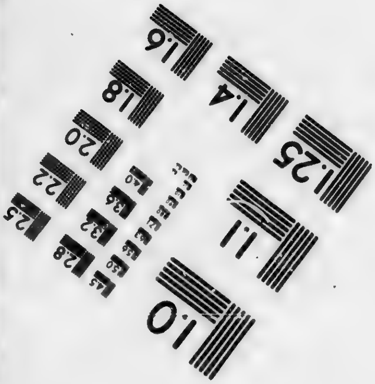

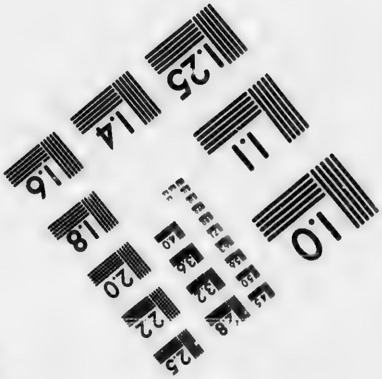

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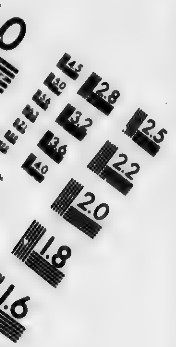
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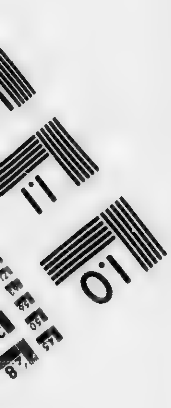
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CHAPTER XXII.

AFFECTIONS OF THE FACE, LIPS, AND JAWS.

Affections of the Face.

A LARGE variety of cutaneous affections are met with involving the integument of the face. The most important of these—viz., lupus, epithelioma, rodent ulcer, and tertiary syphilitic disease—are described elsewhere, whilst the others are scarcely within the scope of a text-book of surgery.

Only a few conditions of the **Eyelids** come under the care of the general surgeon, or require notice here.

Ectropion, or eversion of the eyelids, results from one of two main causes, viz.: (*a*) Simple relaxation, either from facial paralysis or loss of tone of the orbicularis palpebrarum, or the weight of some tumour growing from the lid; and (*b*) cicatricial contraction of the skin of the face following burns or extensive ulceration, as in lupus or syphilis. The lower lid is chiefly affected, and is drawn down and everted, so that its conjunctival surface is exposed. It naturally gives rise to epiphora, or escape of tears over the face, from displacement of the punctum, and to chronic inflammation of the conjunctiva and possibly also of the cornea, which later on may result in ulceration, or even perforation. The *treatment* of cicatricial ectropion calls for some form of plastic operation. The simplest method consists in dividing the cicatrix, and restoring the lid to its normal position by suturing it temporarily to the upper lid, the raw surface being then covered with cuticle according to Thiersch's method (p. 59). In other cases a pedunculated flap of skin derived from the neighbourhood may be utilized. Where the conjunctiva is redundant, a portion of it may be excised.

The most common form of **Tumour** of the eyelid is that known as a **Tarsal Cyst**, which results from distension of a blocked Meibomian follicle. A small rounded tumour is readily felt in the substance of the lid, on the conjunctival surface of which a patch of rosy hyperæmia is observed. *Treatment* consists in incising the cyst from the conjunctival surface, which has been cocainized, and scraping out the interior.

Affections of the Lips.

Hare-lip.—By hare-lip is meant a congenital fissure of the upper lip, which may extend for a variable distance through the soft tissues alone, or may also implicate the bony alveolus and the floor of the nose, and extend backwards through the palate. The name is not a good one, since a hare's lip is cleft in a Y-shaped manner, the fissure being central below, and bifurcating above into each nostril.

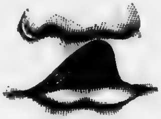

FIG. 225.—SINGLE HARE-LIP, INVOLVING THE TISSUES OF THE LIP, AND NOT EXTENDING INTO THE NOSE.

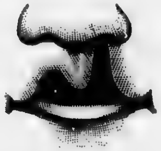

FIG. 226.—DOUBLE HARE-LIP: COMPLETE ON THE LEFT SIDE, INCOMPLETE ON THE RIGHT.

Varieties.—A hare-lip may be *complete* or *incomplete*, according to whether it extends or not into the nostril. It is termed *simple*, if limited to the soft parts; *alveolar*, if the bony alveolus is also involved; *complicated*, if associated with a cleft palate. The defect may exist on one or both sides of the middle line; if *unilateral* or single, it is most common on the left side, in the proportion of two to one; if double or *bilateral*, it is usually, but not invariably, alveolar, and accompanied by a complete cleft of the palate. The central portions of the lip and alveolus (os incisivum) may either retain their normal position, or, as is more frequently the case, be projected forwards at the end of the nose, forming a proboscis-like appendage (Fig. 227, A and B). Even in simple cases

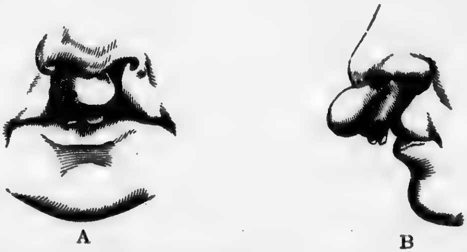

FIG. 227.—DOUBLE COMPLETE HARE-LIP, WITH DISPLACEMENT FORWARDS OF THE CENTRAL PORTION OF THE INTERMAXILLA (OS INCISIVUM).

A, Front view; B, seen in profile.

the nose is deformed, being broad and flattened, a condition which becomes much more marked when the alveolus and floor of the nose are widely fissured. Hare-lip is not uncommonly associated with other deformities—*e.g.*, spina bifida and talipes—and it is frequently transmitted from one generation to another. Occasionally a thin red line, as of a cicatrix, is seen occupying the position of a hare-lip cleft, and is probably due to a persistence of the raphe of union of the labial segments; a slight groove in the alveolus may also be observed at a corresponding point.

Development.—(For fuller details of the development of hare-lip and cleft palate, we must refer readers to 'Harelip and Cleft Palate,' by W. Rose; Lewis and Co., 1891. Space only permits a very brief summary here.) The bony and fleshy parts of the face all originate from the outgrowth of processes around the cavity formed by the bending forward of the primitive cerebral vesicle over the end of the notochord. At about five weeks after conception the primitive buccal cavity or stomodæum has a quinque-radiate appearance, due to the manner in which these processes are formed (Fig. 228). A broad median lappet (fronto-nasal process) descends from above; this is separated by a fissure on each side from the symmetrically-placed maxillary processes, and these again below from the more prominent mandibular

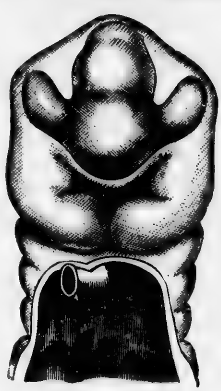

Fig. 228.—Head of Fœtus, of about Five Weeks, from Ventral Aspect (after His), showing the Primitive Stomodæum bounded above by the Undivided Fronto-nasal Process, laterally by the Maxillary, and below by the still separate Mandibular Processes. (Sutton.)

The quinque-radiate appearance is well represented.

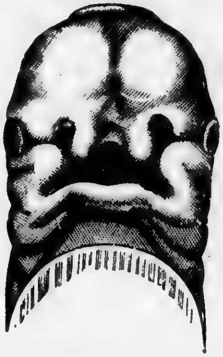

Fig. 229.—Head of Fœtus of a Little Later Date (Six to Seven Weeks), from the Ventral Aspect. (Sutton.)

The mandibular processes have now united; the ocular vesicle is seen on either side towards the upper end of the orbito-nasal fissure, and the fronto-nasal process has developed internal and external nasal processes on either side of the still unclosed anterior nares.

processes, which early unite across the middle line, to form the lower jaw. The fronto-nasal process soon, however, changes, developing four rounded buds, the relations of which are indicated in Fig. 229. On either side of a slight depression in the median line is placed the internal nasal process, from which are produced superficially the central portion of the upper lip, and from its deeper aspect the inner segment of the intermaxilla (endognathion, Fig. 230, EG), carrying the central incisor. Separated from this by a hollow, which subsequently forms the anterior nares, is the rounded external nasal process, from which develop the side of the cheek, the ala nasi, and from its deep side the outer segment of the intermaxilla (mesognathion, MG), and probably the lateral incisor. External to this a fissure runs up to, and even beyond, the primitive eye (naso-orbital fissure), and this is later on closed by amalgamation of the internal and external nasal processes with the adjacent maxillary process, except in the deepest part, which constitutes the nasal duct. The integrity of the upper lip is obtained by the union of the lower parts of the internal nasal and maxillary processes, which thus exclude the external nasal from participation in the free border of the lip. It is doubtless owing to this arrangement that the sulcus or depression around the ala nasi constitutes such a distinct and characteristic feature of the face. At the same time the deeper parts of these nasal processes are uniting with one another, and with the palatal plates which grow horizontally inwards from the under side of the maxillary processes, uniting in a Y-shaped suture, the point of junction of the limbs being situated at the anterior palatine canal. The union of all these elements is taking place from the sixth to the tenth week, and by that date even the uvula, the last part to unite, should be complete.

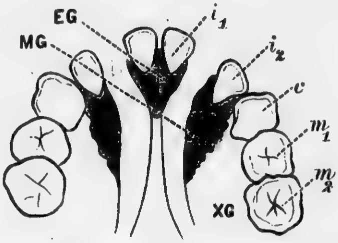

FIG. 230.—DIAGRAM TO REPRESENT THE ALBRECHT THEORY OF HARE-LIP, SHOWING THE SITUATION OF THE CLEFT IN THE ALVEOLUS BETWEEN THE INNER AND OUTER SEGMENTS OF THE INTERMAXILLA.

EG, Endognathion; MG, mesognathion; XG, exognathion; i_1, central incisor; i_2, lateral incisor; c, canine; m_1, m_2, first and second molars.

Ordinary hare-lip is due to a failure of union of the internal nasal process with the structures in external relation with it; if limited to the soft parts (simple hare-lip), the cleft runs between the internal nasal and maxillary processes; if complete or alveolar, between the same two below and superficially, but in addition between the internal and external nasal processes above and on the deep side. The cleft in the alveolus passes between the inner and outer segments of the intermaxilla on each side (Fig. 230), and is thus bounded on the inner side by the central incisor, on the outer side by the lateral incisor. Occasionally two teeth are found to the inner margin of the cleft, the outer of the two being an accessory tooth, whilst the lateral incisor, and presumably the outer segment of the intermaxilla, may be undeveloped, or exist in a very rudimentary condition attached to the maxilla.

The os incisivum, or projecting portion of the intermaxilla, consists of two segments of bone, the two endognathia, united in the median line, and in a child contains two milk central incisors, and the rudiments of the two permanent ones; occasionally, as we have just stated, there may be an accessory tooth developed on one or both sides of the process.

A simple hare-lip does not interfere seriously with the infant's nutrition, but when associated with a cleft palate, and especially if double, considerable trouble may arise, thus necessitating surgical treatment as a life-saving measure at a very early date. It must also be remembered that all movements of the face—*e.g.*, in crying or laughing—exaggerate the deformity from the unbalanced action of the divided orbicularis oris and other muscles.

As to the *period* at which to operate, much discussion has arisen. It is better, however, to allow the infant to get over the shock of entrance into the world, and become acclimatized to an independent existence, whilst at the same time the operation should be performed before the troubles of dentition begin. From six weeks to three months is perhaps the best period to undertake treatment—in well-nourished and healthy children at the earlier date, in poorly-fed and weakly children at the later, unless the inanition be due to the difficulty of giving nutrition owing to the deformity. Under such circumstances the operation may have to be undertaken within the first three weeks.

Operation for Single Hare-lip.—The child should be laid on an operating-table with its arms bound to the body. The surgeon stands behind it, the anæsthetist and assistant one on each side. The operation may be described in three stages:

1. The *lip* is thoroughly *dissected up from the maxillæ* and alveoli by cutting through the reflections of mucous membrane and the attachment of the muscles and other soft parts. This is mainly needed on the outer side, and where there is much flattening of the nose the ala nasi will also require to be separated. This may cause some amount of bleeding, but sponge-pressure will easily control it.

2. The *edges of the cleft* are then *pared*. Many different methods have been employed to accomplish this, but it is only necessary to mention two here. The objects to be attained are not only the union of the cleft lip by means of a cicatrix, which shall be as unobtrusive as possible, but the red margin should be continuous, and the section must be made so that the raw surfaces are larger than are absolutely necessary, so as to allow for subsequent cicatricial contraction without the development of a notch. The methods recommended are as follows:

(*a*) The incision extends from the apex of the cleft, or from within the nostril, in a crescentic manner as far as the red margin (Fig. 231). The knife is then carried obliquely upwards into the cleft, so that a slight angular projection is formed to constitute a prolabium. This is done on each side, and where the nose is much flattened, more tissue is removed on the outer than on the inner side, so that when the parts are sutured together the nostrils become as nearly as possible symmetrical. By this means the depth of the lip is increased to allow of subsequent contraction, whilst the red margin can be made continuous.

(*b*) *Mirault's Operation* (Fig. 232).—The inner margin and apex of the cleft are pared, so as to leave a raw surface; a flap of red marginal tissue, as thick as possible, is then cut from the outer side, and implanted on the bevelled raw surface of the red margin on the inner side, the upper portions of the clefts being also apposed.

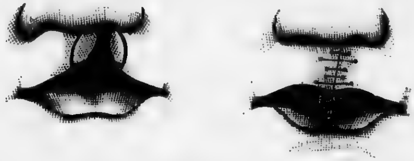

FIG. 231.—ROSE'S OPERATION FOR SINGLE HARE-LIP.

The semilunar incisions are seen extending as far as the red margins of the lip, and also the oblique cuts inwards to form the prolabium. The right-hand figure shows the parts drawn into position; the wide cross lines represent the wire sutures, the narrow ones the catgut or horsehair stitches.

3. *Sutures* are now inserted to maintain the lip in the position into which it can be drawn by the fingers without tension. Two deep silver-wire sutures should be introduced, one just above the red margin, and one close to the nose, to draw into position and steady the nostril, which should be left smaller than that on the other side, to allow for subsequent dilatation, which is certain to occur. Horsehair or catgut stitches are used to bring the exact margins together, the continuity of the muco-cutaneous line being accurately preserved, and the cut edges of the mucous membrane upon the deeper aspect being sutured, each stitch, after it is tightened, being used to elevate and evert the lip to assist the

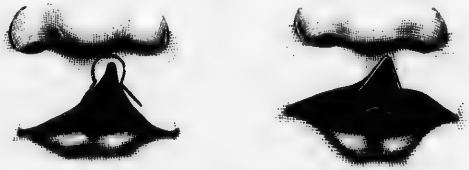

FIG. 232.—MIRAULT'S OPERATION FOR HARE-LIP.

In the right-hand figure the prolabial flap is shown ready to be implanted on the prepared inner side.

insertion of the next. The wound is dressed with a small piece of gauze, and secured by another dry piece cut in the shape of a butterfly, so that the narrow body shall fit over the lip, and the wings spread over the cheeks; this is fixed by collodion, and maintained for some days after the stitches are removed, the deep ones on the fourth day, and the superficial ones about the eighth or tenth. Careful feeding by the spoon is necessary, the mother's milk being drawn off and given in this way, if possible. In simple cases the child may be returned to the breast about the fifth day.

The **Treatment of Double Hare-lip** may be discussed under two headings, viz., the treatment of the os incisivum, and that of the soft parts.

The os incisivum may be treated in a variety of ways. If it retains its normal position, it need not be touched, and the labial clefts are alone dealt with; but if it projects prominently forwards, as is often the case, it must be either removed or replaced. In the former case the central portion of the upper lip is freed from it by dissection, and the base of the process divided with cutting pliers; a small artery in the bone will spurt vigorously, and may need an application of the cautery to stop it. The operation on the lip should be deferred till ten days later. Reposition may be effected by forcible backward pressure, which probably fractures the pedicle of support, and may be dangerous from the fissure extending up to the base of the skull, or from bleeding. Prolonged elastic traction on the process may suffice in the slighter cases, but not in bad ones. The best method of operation is Bardeleben's, who incises the lower border of the septum, strips off the muco-periosteum from either side, and then bends or breaks the bone back into position, fixing it by silver wires, and uniting the lip at once to form a splint to maintain it *in situ*. The advantages claimed for reposition are that the patient retains his own central incisor teeth, and that the normal contour of the jaw and face is not interfered with. Against this plan, however, must be placed the facts that the bone rarely becomes firmly united, that the

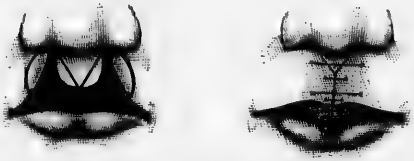

FIG. 233.—ROSE'S OPERATION FOR DOUBLE HARE-LIP.

The central tubercle is pared in a V-shaped manner, and the lateral segments by curved incisions, extending to the red margin, and then upwards and inwards. Only the apex of the central portion is included in the completed lip. The long cross lines represent the position of the wire stitches, the shorter ones of the catgut sutures.

teeth are stunted, and erupt obliquely backwards from rotation of the process, and that its presence prevents the maxillæ from falling together, and increases the difficulties of subsequently closing the palatine cleft. Personally we recommend extirpation in the majority of cases, since the disfigurement can be to a large measure removed by adding a projecting cheek-plate to that which carries the artificial incisors, thus pushing the upper lip forwards.

The soft parts of the lip are dealt with in much the same way as in single hare-lip. They are freely detached from the maxillæ, and the edges pared, as shown in Fig. 233, the central portion being cut into a V, and no attempt made to incorporate it into the free margin for fear of depressing the tip of the nose, whilst the lateral segments are pared as in the single operation. These latter are now drawn together and united in the middle line below the central portion, so that a Y-shaped cicatrix results. One of the deep silver stitches should fix the apex of the V; the other should be inserted just above the red margin. The dressing and after-treatment are as in the single operation. For a time the child may have difficulty in breathing owing to the diminution in the size of the oral aperture, but this is obviated by the nurse being instructed to draw the lower lip down with the fingers, or by painting it in a vertical direction with collodion.

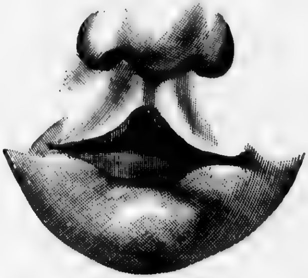

FIG. 234.—MEDIAN HARE-LIP. (PITTS' CASE.)

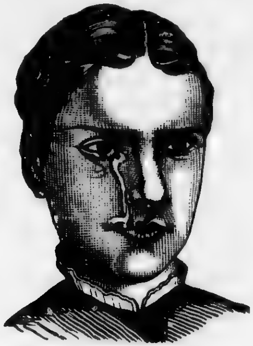

FIG. 235.—OBLIQUE FACIAL CLEFT, OR, RATHER, CICATRICIAL DEFORMITY ALONG THE LINE USUALLY TRAVERSED BY SUCH A CLEFT. (KRASKE'S CASE.)

Other congenital abnormalities of the lips are met with, which, however, can only be briefly mentioned here.

Median Hare-lip may occur in one of two forms: either a simple cleft exists in the middle line (Fig. 234), or there may be an absence of the intermaxilla and nasal septum, causing flattening of the bridge of the nose, and a broad median defect, flanked by the maxillary portions of the lip.

Oblique Facial Cleft is an uncommon deformity, characterized by a cleft, or sulcus, in the face, starting from the usual situation of a hare-lip below, but running up outside the nostril to the inner side of the lower lid (Fig. 235). Coloboma of the iris or choroid is sometimes associated with this rare defect. The deformity is due to non-closure of the naso-orbital fissure, and runs along the line of the nasal duct. It may be limited to the soft parts, or may involve the bones, even laying open the antrum.

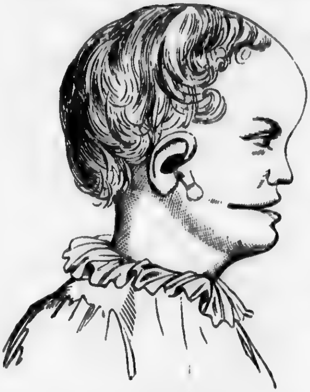

FIG. 236. — MACROSTOMA WITH AURICULAR APPENDAGES. (FERGUSSON.)

Macrostoma (Fig. 236) is characterized by an abnormal width of the mouth, and is due to non-union of the maxillary and mandibular processes. It may be uni- or bi-lateral, and is usually associated with anomalies of development of the ear, accessory auricles being often present. As a rule, a small papilla on the upper and lower margins will indicate the true limits of the mouth, being constituted by the points of attachment of the orbicularis. The existence of these is of great importance as indicating the extent to which the cleft must be pared in order to restore the mouth to its normal size.

Mandibular Clefts are exceedingly rare. They are due to non-union of the mandibular processes in the middle line, and involve either the soft tissues of the lower lip alone, or may extend to the bone, and even the tongue. Treatment is as for ordinary harelip.

Microstoma is the term applied to a condition in which the fusion of the parts entering into the formation of the lips progresses to a greater extent than usual, so that the oral orifice is contracted. It may be associated with defective development of the lower jaw. In the more severe cases, where the mouth is extremely narrowed, a transverse cut should be made outwards on each side, and the mucous membrance stitched to the skin.

Macrocheilia, or hypertrophy of the lip, occurs in three forms: 1. The congenital variety, a condition analogous to macroglossia, and due to a congenital distension of the lymphatic spaces, or chronic lymphangiectasis, accompanied by overgrowth of the connective tissue. The lower lip is most often involved, and is firm, thickened, and everted, causing considerable deformity. The treatment consists in the removal of a V-shaped portion from the centre. 2. An acquired form occurs in children and young people with a tubercular inheritance, constituting the so-called 'strumous lip.' Either lip may be affected, but perhaps more frequently the upper; the thickening is probably of a chronic œdematous nature, maintained by the persistent irritation of cracks and fissures. If these can be healed, and the general health improved, diminution in the size of the lip soon follows. 3. In adults, macrocheilia is in almost all cases due to tertiary syphilis. The lower lip is most often enlarged, and becomes thick and hard. It is due to the diffuse sclerosis characteristic of tertiary mischief. General treatment, and not local, is needed.

Syphilitic Affections of the lip are not uncommon. A *primary* chancre may be caused by kissing, orby smoking an infected pipe, or drinking from a glass with an infected rim. It usually presents a smooth ulcerated surface, discharging a small amount of sero-pus, resting on a mass of infiltrated tissue which may extend over the whole lip (Fig. 237). The induration is not so great as in chancres upon the genital organs, but the infiltration is much more extensive. An indolent enlargement of one or more of the submaxillary lymphatic glands occurs very early, and the disease usually runs an acute course. Ordinary specific treatment is all that is needed. A labial chancre may very closely resemble epithelioma, but is distinguished from it by its rapid development up to a certain point, by the early implication of the glands, which soon become very large, by the absence of typical cachexia, by the age of the patient, and the course taken by the case, whilst the local appearances are not strictly those of epithelioma. The surface is usually flattened, and less warty and irregular than in epithelioma, whilst the skin is more involved than the mucous membrane. Should the chancre have existed for any time, the presence of a rash or sore throat may materially assist in forming a diagnosis. Moreover, it is said to be more commonly met with on the upper lip, whilst epithelioma is usually seen on the lower (compare Figs. 237 and 239). In the *secondary* stage mucous tubercles are frequently met with, involving the inner side of the lip and the angle of the mouth. In the *tertiary* period serpiginous ulceration and gummata may occur, or the diffuse induration described above. In *inherited* syphilis, cracks and mucous tubercles are constantly present, and may be so extensive as to leave cicatrices radiating from the mouth, which are very characteristic.

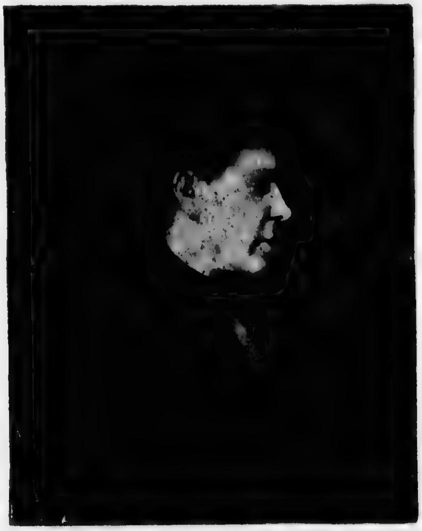

FIG. 237.—CHANCRE OF UPPER LIP.

The swelling due to the enlargement of the submaxillary lymphatic glands can also be seen.

Cracked Lips (or, as they are often called, *chapped lips*) are usually the result of cold weather, a central crack or fissure forming which is extremely painful, and liable to bleed very readily on everting or stretching the part. The lower lip is that generally affected. In tubercular children more than one may occur, and may tend to persist, giving rise to a considerable degree of induration and infiltration, and perhaps leading to glandular trouble. All that is needed in the shape of *treatment* is the application of a little lanoline or cold cream, but if they persist, it may be advisable to touch them with nitrate of silver.

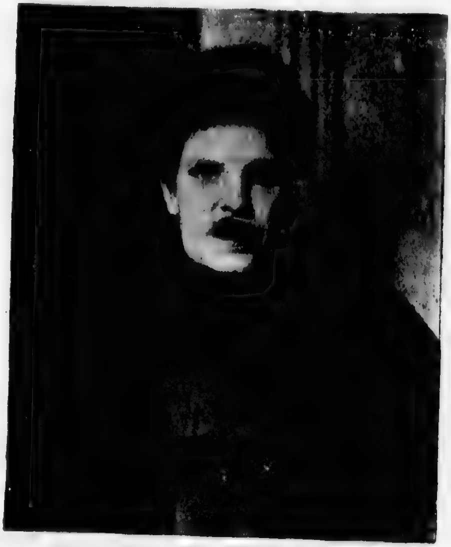
FIG. 238.—CHANCRE OF UPPER LIP.

Herpes Labialis is a condition usually associated with catarrh, and not unfrequently with pneumonia or other fevers. Either lip may be affected, and the herpetic eruption is, as a rule, quite limited in extent. It consists of a number of little vesicles situated on a hyperæmic and painful base; after a few days the vesicles become transformed into pustules, and these in turn burst and dry up, the whole affection lasting perhaps a week or ten days. No special treatment is called for. If the inner aspect of the lip is affected, the epithelium early becomes sodden and is shed, so that the vesicular stage is much shorter.

Mucous Cysts occur on the inner side of the lip in the form of small rounded swellings, which are translucent and contain a glairy fluid. They are often due to trauma, whereby the opening of the gland is blocked. The whole cyst wall should be dissected out, and the wound closed by stitches.

Nævi are frequently met with in the lip. If confined to the inner aspect they may be dissected out, but when large and involving the whole thickness, they should be dealt with either by injection of carbolic acid or by electrolysis; in the former method care must be taken to prevent the fluid injected entering the general circulation, by compressing the tissues in the neighbourhood with two pairs of dressing forceps, the blades of which are protected by indiarubber tubing.

Warty Growths are often seen on the lower lip, especially near the angle, and may then simulate epithelioma. They are distinguished, however, by the fact that ulceration is not often present, that the lymphatic glands are not involved, and that there is but little infiltration of the base. They should, however, be removed as early as possible, since malignant disease often starts from them.

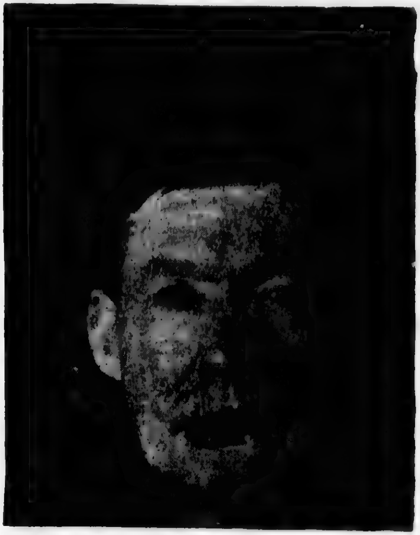

FIG. 239.—CHRONIC EPITHELIOMA OF LOWER LIP

Epithelioma of the lip usually occurs in men of the working classes, and is commonly stated to be due to the irritation produced by smoking a short clay pipe, which is allowed to rest on one or the other side near the angle. A semicircular notch will frequently be noticed in the teeth of the upper and lower jaw, corresponding to the situation of the growth on the lip, and caused by the constant friction of the pipe-stem. It may also start opposite the site of some projecting rough or carious tooth. It is but rarely met with in women, occurring in England in not more than 5 to 6 per cent. of the cases, and of these, according to Hutchinson, half are clay-pipe smokers, whilst in Warren's female cases, amongst the Irish in Glasgow, three-quarters were smokers. On the other hand, Kocher reports that 8 or 9 per cent. of those affected with lip cancer in Switzerland were women, and of these none smoked. It has also been observed to be more common amongst country folk who use the short clay pipe than amongst the cigarette and cigar smokers in towns. Von Winiwarter reports 70·6 per cent. as occurring in country people, whilst Kocher has very similar statistics.

The disease may start as an induration around a crack or fissure, which gradually extends, forming a typical malignant ulcer; or as a wart-like growth, which fungates and ulcerates; or as a chronic infiltration leading to an irregular nodular thickening of the lip (Fig. 239).

If allowed to run its course unchecked by treatment, the disease steadily progresses, forming an ulcerated mass of greater or less size, and even involving the jaw. The submental and submaxillary glands are early implicated, and secondary deposits are also found in the glandulæ concatenatæ. Beyond this, however, the disease rarely extends, visceral complications being uncommon. When a fatal issue results, it is generally caused by the secondary growths in the neck, which attain considerable dimensions and then ulcerate, this stage being possibly preceded by one of cystic degeneration. From these ulcerated surfaces a variable amount of discharge occurs, varying with the septicity or not of the wounds. Hæmorrhage is also likely to follow from some of the vessels in the neck being laid open.

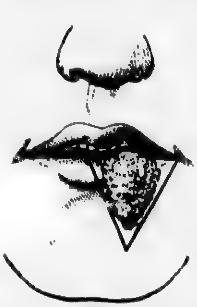

FIG. 240.—V-SHAPED INCISIONS FOR REMOVAL OF EPITHELIOMA OF LIP.

The **Diagnosis** is rarely doubtful, but occasionally warty growths, or even a primary chancre, may be mistaken for it (*q.v.*). The clinical history, as a rule, suffices to determine the nature of the mass, as also the character of the base and the appearance of the parts; but in uncertain cases the removal of a small portion under cocaine, and its microscopic examination, is required to set doubts at rest.

Treatment.—The primary growth can almost always be excised completely without much difficulty; if glands are also enlarged, these should be removed where such is feasible, but when once the concatenate group has been attacked, they often contract such adhesions as to render their extirpation impracticable. If the growth is limited to one part of the lip, a V-shaped wedge extending half an inch beyond it in all directions may be taken away (Fig. 240), and the wound closed, as in a case of hare-lip, without much deformity resulting. When it is more extensive considerable ingenuity is called for in order to make good the defect. One plan that often gives excellent results is to excise the growth by a somewhat larger V-shaped incision, and then to extend the labial fissure transversely to one or the other side, or to both, dissecting up these segments from the bone; the flaps can then usually be brought together, whilst the mucous membrane is united to the skin along the margin of the new lip.

When the whole lower lip requires removal, *Symes' operation* may with advantage be performed. It consists first of all in the complete excision of the disease and lip. Two curved incisions are then made, starting from the middle line of the wound, and extending downwards under the chin, to terminate below the angles of the jaw, an inverted V-shaped portion of skin between them remaining fixed to the symphysis menti to form a base of support for the new lip. The lateral flaps are now freely dissected up, raised, and united one to the other in the middle line, so as to constitute the new lip, an inverted Y-shaped cicatrix resulting. The elasticity of the skin in this region allows this to be accomplished, and the whole wound closed, without leaving any part to granulate. The mucous membrane should be finally stitched over the upper free margin to the skin. Healing by first intention usually follows.

If the whole of the upper lip needs to be removed, it may be restored in a variety of ways. Perhaps one of the best consists in making incisions which skirt the alæ nasi on each side, and then extend outwards into the cheeks sufficiently to allow of the tissues, when they have been freed from the maxillæ by undercutting, to be drawn together in the middle line. In such cases care must be taken not to encroach on Stenson's duct.

Affections of the Gums and Alveolar Processes.

Spongy Gums are not unfrequently met with as a result of the administration of mercury, or from scurvy. They are characterized by being soft and congested, bleeding readily on pressure, and perhaps showing signs of ulceration. All that is necessary is the correction of the determining cause and the use of an alum gargle.

Alveolar Abscess is almost always associated with suppuration around the fang of a carious tooth. The alveolar walls become expanded, and the pus finds its way over the edge of the bone, or even through the osseous tissue, under the external periosteum. If limited in extent, it perforates the gum directly, and is then known as a gum-boil; but it occasionally burrows beneath the periosteum, which is stripped from the bone, and may thus lead to an abscess of larger size, possibly resulting in necrosis of the jaw. The formation of an alveolar abscess is almost always associated with a considerable amount of pain of a very irritating nature, and when extensive may give rise to serious constitutional disturbance. Occasionally graver complications may ensue; thus, in the upper jaw the antrum may be opened, and suppuration in this cavity may follow, whilst in the lower the abscess may travel downwards and burst externally, either close to the lower margin of the bone or in the neck. A troublesome sinus results, which can only be cured by the removal of the tooth, and even then a depressed and adherent cicatrix ensues, which is extremely unsightly. The most essential point in the *treatment* necessarily consists in the removal of the offending tooth. Often this is quite sufficient, and possibly the tooth may come away with an abscess cavity attached to one of the fangs. When suppuration occurs beneath the periosteum, the pain is at first relieved in measure by hot fomentations, but as soon as fluctuation can be detected an incision is made through the mucous membrane, and the cavity thoroughly opened up. If a small sinus persists after removal of the tooth, it must be opened up and any carious or necrosed bone removed.

Pyorrhœa Alveolaris (or **Rigg's Disease**) consists in an inflammatory condition of the margins of the gums, accompanied by a muco-purulent discharge and the gradual loosening and throwing off of the teeth, so that after a while the patient is likely to become edentulous. Occasionally the process is limited to a few teeth, but is almost always associated with excessive deposit of tartar around them. Nothing definite is known as to its nature or causation, and but little more as to its treatment. All that has been recommended consists in the removal of tartar and the application of astringents and antiseptics.

Hypertrophy of the Gums is met with in the form of a sessile overgrowth, sometimes almost cauliflower-like, around and between the teeth; it occurs most frequently in children, but occasionally in older subjects. It is sometimes associated with carious teeth, and should be cut away with a scalpel.

Epulis.—By this term is meant a tumour growing from the alveolar periosteum. Two varieties are described, viz., the simple and the malignant.

A **Simple Epulis** is of a fibromatous nature, and may arise from the alveolus of either jaw, although it is more common in the lower. It is possibly due to the irritation of diseased teeth, and although most marked on the outer aspect, it burrows between the teeth, and is also found on the inner side. It appears as a red fleshy mass, smooth, or perhaps lobulated, of an elastic consistency, and possibly associated with a little superficial ulceration. It is covered with mucous membrane, and may contain a few spicules of bone. The *treatment* consists in removing the growth together with the teeth or stumps with which it is connected. If small, it will suffice to cut it away and scrape the bone from which it arises; but if large, or if it recurs after such treatment, the portion of the alveolus from which it springs must also be excised. This is best accomplished by extracting a tooth on either side of the tumour, and cutting vertically through each socket with a saw, the two incisions being united below with a chisel, so as to remove a quadrangular portion of bone without interfering with the continuity of the jaw.

Malignant Epulis.—This title is applied to a sarcomatous tumour of the alveolus. It is usually of a myeloid character, and forms a soft rapidly-increasing mass of a dusky purple colour, and readily running on to ulceration or fungation. The deeper portions of the growth may contain an ossific deposit. As with all forms of myeloid growth, it is only locally malignant. *Treatment* consists in free removal of the mass and of the portion of alveolus from which it arises. In the upper jaw this usually necessitates excision of the complete palatal segment of the maxilla, but in the lower jaw it may be possible to maintain the continuity of the mandible by merely removing a quadrilateral portion in the same way as for a simple epulis.

Epithelioma and **Melanotic Sarcoma**, arising from the gum, are both occasionally met with. Epithelioma in this situation rarely fungates, but rather tends to invade the bony tissues, and in the upper jaw to extend upwards to the antrum; hence, it is sometimes termed a 'creeping or burrowing epithelioma.' The ordinary signs of this disease become evident, lymphatic glands are enlarged, and typical ulceration of the gum follows. The only treatment possible consists in free excision of the growth, together with the portion of bone affected.

Necrosis of the Jaw.—Causes: (1) Subperiosteal alveolar abscess, connected with carious disease of the teeth. (2) Traumatism, such as blows on the jaws, with or without fracture, in the latter instance being due to septic periostitis or osteo-myelitis, owing to the lesion becoming compound. It has also followed the extraction of a tooth with dirty forceps, setting up infective osteomyelitis. (3) In tertiary syphilis necrosis also occurs, affecting most frequently the palate or alveolar borders. (4) It occasionally results from mercurial poisoning, but such is rarely seen at the present day. (5) Phosphorus necrosis is met with amongst those who work in lucifer-match factories. It is only when ordinary phosphorus is used that necrosis occurs; the amorphous form is harmless. The fumes are supposed to gain access to the jaws through carious teeth, giving rise to a somewhat acute inflammation, which terminates in necrosis. A considerable amount of new bone forms beneath the periosteum, and the sequestrum, which is curiously gray and porous, like dirty pumice-stone, is always slow in separating. Both jaws are affected in much the same proportion of cases. (6) Necrosis may follow one of the exanthemata, arising as an infective idiopathic or embolic osteomyelitis, and then probably affecting a considerable extent of bony tissue, possibly the whole mandible. (7) Tubercle is occasionally responsible for this condition.

The **Clinical Phenomena** associated with necrosis of the jaw are necessarily much the same whatever the cause. In the acute form, inflammatory symptoms are well marked, the face becoming swollen, red and shiny, and severe pain being experienced. Sooner or later an abscess forms, which may point either in the mouth or on the face, or the pus may burrow downwards for some distance into the neck. Sinuses persist, discharging the most offensive pus; a new case of bone forms, enclosing the sequestrum in the lower jaw, but in the upper this is but rarely noticed.

Treatment.—In the early stage the mouth should be fomented, and as soon as there is any suspicion of pus a free incision should be made down to and along the bone. When necrosis has occurred, it must be treated in the ordinary way, the sinuses being flushed out with an antiseptic solution two or three times a day until the sequestrum is loose; it is then removed, if possible, from within the mouth by sequestrotomy.

Affections of the Antrum.

Suppuration of the Antrum frequently arises from disease connected with the fangs of the first or second molar or bicuspid teeth; it not uncommonly extends from the nasal cavities in connection with disease of the middle turbinated bone, and is occasionally lighted up by injury.

The **Symptoms** produced are often extremely equivocal, and the condition may be present for some time without being recognised. In the *chronic* forms there is usually a little local tenderness over the antrum, and perhaps some swelling of the mucous membrane or of the cheek, whilst there is an intermittent discharge of pus into and from the nose. This varies considerably in amount and character, being sometimes extremely offensive. It is stated by Heath that, although the patient notices the fœtor himself, it is not, as a rule, discerned by other people, thus differing from ozæna. On holding the patient's head forwards, it can be demonstrated that there is an overflow of pus into the nostril, and sometimes when the patient reclines it flows back into the pharynx. Should the opening into the nose become blocked, all the symptoms are aggravated, the pain becoming more marked and the swelling increasing. *Signs of distension* of the cavity may also be produced in this way; such may be manifested in four directions: (*a*) Inwards, causing obstruction to nasal respiration, and possibly epiphora, from compression of the nasal duct; (*b*) upwards, leading to protrusion of the eyeball or exophthalmos; (*c*) downwards, resulting in depression of the side of the palate, and possibly irregularity in the line of the teeth; and (*d*) outwards, giving rise to a somewhat characteristic projection of the cheek beneath the malar eminence. Under these circumstances, a finger inserted into the mouth, between the cheek and the bone, will detect a loss of resistance in the anterior wall of the antrum, and if the distension has lasted long, eggshell crackling may be detected, or the whole anterior wall may be absorbed and an elastic swelling take its place.

In *acute* cases all the above phenomena may be present in an accentuated degree, accompanied by severe tensive pain and some amount of febrile disturbance. Necrosis of the lining bony walls may also be induced, owing to the fact that the mucous membrane is closely adherent to the periosteum.

The **Diagnosis** of suppuration within the antrum is by no means readily made, since there are many conditions which simulate it somewhat closely. Perhaps the most important sign is the periodic discharge of pus from the nose, and if this can be induced by change of position of the head, it is almost pathognomonic. The association of such a phenomenon with a dead or painful first molar or bicuspid is also a most suggestive occurrence. Another method which has been recommended is that known as *transillumination of the antrum*. A small electric lamp is placed within the mouth, and if the patient is in a dark room, and his antra are normal, the cheeks, lips, and lower margins of the orbits become of a rosy-red colour. If, however, the cavities are occupied by pus, blood, or a growth, the parts remain dark. Transillumination does not answer in every individual, and hence the value of the test is much diminished. The presence of illumination excludes intra-antral growths or abscess, but its absence, unless unilateral, is not of much significance.

The **Treatment** of this affection consists in freely opening the antrum from the mouth, so that the cavity may be washed out and drained. Various methods have been adopted to attain this end, and perhaps the most satisfactory consists in making an incision through the anterior wall above the first molar after dividing the mucous membrane. This tooth, the fangs of which encroach upon the cavity, may also be drawn, and the anterior wall of its socket cut or gouged away. The cavity is subsequently washed out freely every day until it has healed. To prevent the opening from closing too quickly, a wire tube made of silver, and fitted to a small tooth-plate, should be inserted. It is taken out and cleansed night and morning, and plugged during meals. In those cases secondary to intranasal disease, the first essential is to deal with the origin of the mischief by scraping away all granulation tissue and diseased bone. The antrum may in this way usually be opened from the nose, and in the majority of cases this will suffice to enable the cavity to be irrigated and drained. In old-standing cases where chronic suppuration persists, the cavity should be freely opened up, examined by the finger, scraped, flushed, and stuffed with gauze.

Hydrops Antri is the term applied to a chronic distension of the antrum with a glairy mucoid fluid, somewhat similar in character to that contained in a ranula. The condition is painless, and free from inflammatory phenomena, and as the expansion increases, eggshell crackling of the anterior wall, or even distinct fluctuation, may be observed. It was formerly supposed to arise from obstruction to the aperture into the nose and retention of secretion, but it is in reality due to a cystic tumour forming from the mucous membrane and the glandular elements contained therein. The *treatment* required is to thoroughly open the cavity through the mouth after dividing the mucous membrane, and removing a sufficient portion of the anterior wall to enable it to be washed out and drained.

Various **Tumours** may originate in the antrum, *e.g.*, mucous polypi, fibromata, odontomata, osteomata, sarcomata, and cancers. When limited to the cavity, they produce no definite symptoms, except when large enough to give rise to expansion of its walls. Malignant growths, however, usually pass beyond the limits of the antrum, and lead to the usual signs of malignant disease of the upper jaw. *Treatment* consists in removing simple growths, if possible, without interfering with the integrity of the maxilla. This may be accomplished by reflecting the overlying cheek, as in removal of the upper jaw. For malignant tumours, excision of the whole bone is the only possible remedy.

Tumours of the Upper Jaw.

Many of the **Simple Tumours** springing from the upper jaw have been already described amongst those involving the alveolar border and antrum. Only a few remain to be dealt with.

Osteoma occurs either in the form of a tumour composed of compact tissue, then usually growing within the antrum, or it is occasionally met with as a diffuse symmetrical overgrowth, constituting the condition known as *leontiasis ossea*. A few cases of **Chondroma** have also been reported.

By **Leontiasis Ossea** is meant a disease, fortunately extremely rare, characterized by the formation of diffuse hyperostoses from either the cranial and facial bones, or from both. It usually commences in young adult life, and both rickets and syphilis have been suggested as playing some part in its causation, although really nothing definite as to its origin is known. Nodular outgrowths of soft spongy bone are gradually developed, increasing slowly in size, and giving rise to irregular bony protuberances projecting beneath the skin, and when affecting the maxillæ and mandibles leading to an extremely repulsive appearance of the individual. Sometimes only the cranial bones are affected, at other times only the jaws, whilst occasionally the whole skull participates in the change, which is almost always symmetrical. As growth progresses, the new bone tends to encroach on the cavities contained within the skull, so that the antrum may be obliterated, the eyes may protrude owing to the contraction of the intra-orbital space, and even coma and death may supervene from cerebral compression. Prior to this, however, a variety of symptoms, especially neuralgia, may be induced by pressure on the cranial nerves. *Treatment* is only occasionally possible, and consists in the removal of the projecting masses of bone by the chisel. A few fairly satisfactory results of such a procedure have been recently recorded.

Malignant Disease of the Upper Jaw occurs in the form of sarcoma or cancer.

Sarcoma is perhaps the more common, and may originate either from the anterior wall, from the cavity of the antrum, or from the spheno-maxillary fossa behind the bone. Sarcomatous naso-pharyngeal polypi may also spread from the nose, and involve the maxilla secondarily. Not at all uncommonly these growths have a considerable ossific deposit within them, and this is occasionally so extensive as to obliterate the antral cavity, and convert the whole bone into a solid mass.

Cancer occurs in the form of squamous epithelioma, originating either from the gums or from the antral mucous membrane; or as a columnar cancer starting in the glandular tissue, found either in the nasal or antral cavities. The encephaloid form is rare.

The **Clinical Features** of all forms of malignant disease are practically identical.

If arising from the anterior aspect of the bone, a tumour is produced which projects under the cheek, the tissues of which are invaded by it: it tends to travel down towards the mouth, and is readily detected through the mucous membrane. It may, however, spread deeply, and in time involve the cavity of the antrum. As a rule, it causes no obstruction to nasal respiration, and no epiphora, or, at any rate, only in the later stages.

If it originates within the antrum, the usual signs of distension of that cavity are produced, associated with a foul, and often blood-stained, discharge from the nose, within which the ulcerated surface of the growth may be seen. Epiphora is caused by pressure on the nasal duct, and the passage of air through the nose on that side is also impeded.

If the growth commences behind the maxilla, it usually springs from one of the walls of the spheno-maxillary fossa, and is then characterized by a great tendency to spread or burrow in all directions. Thus, it may perhaps push the whole bone bodily forwards without encroaching upon the antrum; sometimes it finds its way outwards to the pterygoid fossa through the pterygo-maxillary fissure, or inwards to the nose through the spheno-palatine foramen, or even up into the orbit; whilst more rarely it may spread downwards along the posterior palatine canal, so as to appear at the postero-external corner of the palate; in the later stages it is not uncommon to find the antral cavity also involved, and even the base of the skull is not exempt from the ravages of the disease.

The **General Signs** of a malignant growth of the superior maxilla consist in the formation of a tumour which, according to its origin, produces various effects, but finally tends to destroy the bones, and occupy the whole of the maxillary region. Such is usually accompanied by nasal obstruction, epiphora, and frequently by a discharge of blood or pus from the nares. Severe pain may accompany the process, especially affecting the second division of the trigeminal, but not invariably. Neighbouring lymphatic glands become enlarged, more especially in the carcinomata; those in the submaxillary region are first involved, and afterwards those in the anterior triangle; secondary deposits in the viscera may also occur somewhat later. The tumour follows a typical malignant course, and, owing to the great vascularity of the parts, its onward progress is very rapid.

The **Diagnosis** of a simple tumour of the jaw from malignant disease should be readily made; the later age at which it appears, the rapidity of its growth, the greater pain and more abundant discharge from the nose, the associated enlargement of the lymphatic glands, and the tendency to spread and to encroach upon surrounding structures, all point to malignant disease. In some cases, however, an exploratory incision must be made into the antrum, in order to make certain of the diagnosis. More frequently the existence of a tumour at all is for some time entirely overlooked, some one prominent symptom, such as neuralgia and epiphora, being treated without ascertaining the cause.

Treatment consists in free removal of the growth, if such be practicable, together with total or partial ablation of the superior maxilla. Where, however, the tissues of the cheek have been invaded, or where the growth has spread beyond the limits of the antrum, the surgeon may well hesitate before recommending an operation, since it is very unlikely that complete eradication can be effected, and the risk of the proceeding may be so great as to endanger the patient's life. Hence, in those cases which spread from behind the maxilla, operative treatment should never be lightly undertaken.

Excision of the Superior Maxilla.

This operation is done for the purpose of removing new growths, simple or malignant, either originating in the upper jaw, or extending into it, whilst it is also sometimes employed as a preliminary in dealing with tumours of the base of the skull. Naturally the exact steps vary considerably in different cases according to the character and extent of the disease; the description here given applies to a typical case, where no unusual complications are present.

Operation.—The patient's head and shoulders are well raised, and anæsthesia is kept up by means of chloroform given by Junker's apparatus. Some surgeons undertake a preliminary tracheotomy, and plug the pharynx, in order to prevent the entrance of blood into the air passages, but such is scarcely necessary or desirable if good assistance is procurable, since it increases to a certain extent the risks of the operation. The proceeding may be described in stages as follows:

Stage I.: Incision and Reflection of the Soft Structures of the Cheek.—The central incisor tooth of the affected side having been extracted, the upper lip is divided in the middle line as high as the columna nasi; the incision is now carried round the ala nasi to the side of the nose, and thence to a point half an inch below the inner canthus; it then extends on the same level along the lower orbital margin to a point below its outer border, or even to the zygoma (Fig. 241). The flap thus marked out is raised from the bone, and reflected outwards so as to clear the zygomatic eminence, the knife being carried as near to it as is considered wise, and the more important arteries secured, as they are divided, by Spencer Wells' forceps.

Stage II.: Division of the Bony Attachments.—A keyhole-saw is now passed into the nose, and the alveolus and hard palate divided from before backwards through the empty socket of the central incisor tooth. There is no need to incise the muco-periosteum previously, as is sometimes recommended; division by the saw causes less bleeding than the use of the knife. The side of the nose is then freed from its bony attachments, and the periosteum stripped from the floor of the orbit, the eyeball being protected by a copper spatula. It is most essential that the orbital periosteum should be preserved intact, unless diseased, so as to prevent the invasion of the orbit by a septic cellulitis. The nasal process of the superior maxilla is now cut through with a saw; and also the malar bone divided so as to open into the spheno-maxillary fissure. The surgeon now takes a pair of long-handled cutting pliers, and completes the division of each of these bony attachments, but reversing the order, dealing with the malar bone first, then with the nasal attachments, and finally with the palate. The cutting pliers must always be applied with the smooth surface towards the tissues which are to be left, and the bevelled surface towards the part which is to be removed (Fig. 242). When the section

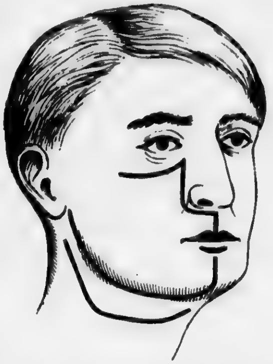

FIG. 241.—INCISIONS FOR REMOVAL OF SUPERIOR MAXILLA (UPPER DARK LINE); FOR REMOVAL OF LOWER MAXILLA (MIDDLE DARK LINE); AND FOR KOCHER'S OPERATION FOR REMOVAL OF TONGUE (LOWER DARK LINE).

of the palate is completed, the cutting pliers are used as a lever to prise the bone out of its bed, the sound bone acting as a fulcrum, the posterior attachments being thus fractured. The pterygoid processes are broken through close to their origin from the sphenoid, and the lateral mass of the ethmoid yields along the inner orbital margin.

Stage III.: Removal of the Bone and Tumour.—The bone is now seized by lion forceps, one blade holding the alveolus, and the other the infra-orbital border, and twisted out; the mouth is gagged open, and the soft palate, if free from disease, is divided from its attachment to the hard by a transverse incision, and all other muscular connections severed. Some care is needed in the removal of the projecting hamular process. Considerable hæmorrhage may occur at this stage from some of the branches of the internal maxillary artery, especially the infra-orbital and posterior palatine; but it is readily checked temporarily by plugging the wound firmly with a sponge, and subsequently the chief vessels are secured by ligature, whilst smaller bleeding points may be touched with the cautery. Any outlying portions of the tumour are now dealt with, and the cavity, after being dabbed over with a solution of chloride of zinc (40 grains to the ounce), is plugged with strips of cyanide gauze soaked in the iodoform glycerine emulsion. The wound in the cheek is closed, the greatest care

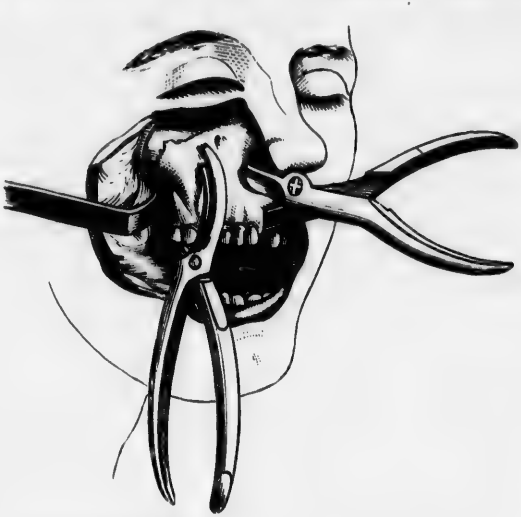

FIG. 242.—EXCISION OF THE SUPERIOR MAXILLA.

being taken to secure accurate apposition of the flap, especially at the lip margin, and dressed with gauze secured with collodion.

In the majority of cases there is comparatively little shock, and the patients do remarkably well—at any rate, for a time—although, unfortunately, recurrence is only too likely to follow. The plug in the nose is left *in situ* for twenty-four hours, and then removed through the mouth, and the wound irrigated with some antiseptic solution. The plug may be replaced, but can usually be dispensed with if the patient washes out the cavity several times a day. Healing is effected by granulation, and of course a large gap communicating with the mouth remains. This can be subsequently remedied by an obturator, to which is attached a cheek-plate to prevent falling in of the cheek. The patient is fed for the first few days by the rectum, or by a tube passed into the pharynx, but soon acquires the knack of swallowing fluids, especially when the soft palate has been left intact.

Partial Operations.—Many modifications of the above may be undertaken in order to minimize, as far as possible, the amount of tissue removed, and to prevent any unnecessary scarring. When the alveolus alone needs removal, the external incision may be limited to division of the lip, the soft tissues of the cheek being stripped up as far as necessary from the bones. If part of the body of the bone requires removal as well as the alveolus, only the nasal half of the incision need be made, and, indeed, wherever it is possible, the orbital plate should be left in order to prevent displacement downwards of the eye, and subsequent diplopia. In such cases a saw is carried from the anterior nares across the front of the antrum to the malar bone. The alveolus and palate are now divided, and the growth with this portion of bone detached from its posterior connections. The upper part can also be removed separately, the palate and alveolus being left intact; the operation should, in fact, never be looked upon as a fixed and definite proceeding, but may be modified to suit the particular exigencies of the case.

Various forms of osteoplastic resection of the superior maxilla required for the treatment of tumours of the naso-pharynx are described at p. 693.

Tumours of the Lower Jaw.

These are similar in character to those met with in the upper jaw. Thus, **Chondroma**, **Osteoma**, **Fibroma**, and the simple and malignant forms of **Epulis**, have been already described.

Dentigerous Cysts form around teeth which are so misplaced that they cannot erupt; though occasionally seen in the upper jaw, they are much more common in the lower. Their characters and nature have been already described under the title of *follicular odontomes*, at p. 152. They are met with in young people, and give rise to expansion of the jaw (Fig. 243); the tumour thus formed is at first hard and solid to the touch, but later on egg-shell crackling, and even true fluctuation, are observed when the encasing wall has become thin or absorbed. Some irregularity in the line of the permanent teeth may sometimes be noted, but not necessarily, since the milk tooth corresponding to that which is misplaced is not always shed, owing to the absence of pressure from below. Occasionally suppuration within the cavity may be caused by an extension of inflammation from the fang of a neighbouring tooth, or by the cyst being opened during its extraction. A sinus discharging offensive pus will then form, and the surrounding tissues become red and congested. *Treatment* consists in freely opening the cyst through the mucous membrane, and removing a sufficient portion of the bony wall to allow of the extraction of the misplaced tooth. The cavity is left open and allowed to heal by granulation, during which process strict attention to cleanliness must be observed.

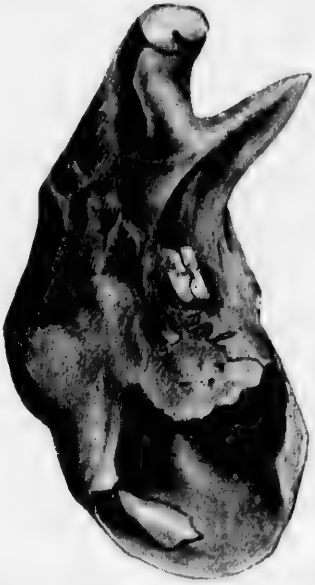

FIG. 243.—DENTIGEROUS CYST, SHOWING EXPANDED CONDITION OF THE LOWER JAW, AND UNERUPTED TOOTH LYING HORIZONTALLY WITHIN IT. (COLLEGE OF SURGEONS' MUSEUM.)

Fibrocystic Disease of the Jaw (*epithelial odontome*, p. 152) has been already mentioned as characterized by the formation of tumours, often of great size, which consist of spaces lined with cuboidal epithelium, and supposed to originate from the enamel organ. They occur most frequently in young people, and, as a rule, run a perfectly benign course, although from their size they may lead to serious results. The only *Treatment* consists in complete removal of the affected portion of the jaw.

Myeloid Sarcoma is met with in the lower jaw, not only in the form of a malignant epulis, but also occasionally as a central growth, usually attacking the median portion of the bone, which becomes expanded in the same way as when a similar disease attacks the end of a long bone. It presents but slight evidences of malignancy, and may be treated in the first place by opening the outer shell of bone and scraping away the soft contents, the cavity thus formed being swabbed out with pure carbolic acid, and plugged with gauze. Should it recur, the affected portion of the bone must be removed. Whenever possible, a bridge of osseous tissue should be left so as to connect the two segments of the jaw; if this is not attended to, they are likely to fall together, and lead to considerable trouble. If the whole thickness of the bone is excised, a wire frame or splint should be introduced between the fragments with the same object. It is replaced later on by a suitable plate carrying artificial teeth.

Round- or Spindle Celled Sarcoma also occurs, usually springing from the periosteum, the deeper parts undergoing ossification. The course is typically malignant, and free removal of the affected portion of the bone must be undertaken. Melanotic sarcoma has also been observed.

Epithelioma invades the lower jaw as an extension of a similar affection arising either from the gum, lips, or tongue. Excision of a portion of the bone together with the primary disease is always called for, unless it has extended so far as to render extirpation impracticable.

Excision of the Lower Jaw is called for in the treatment of various tumours arising from that bone, as also sometimes for extensive necrosis. In the latter case it may be possible to deal with it from the mouth, but when required for the treatment of malignant disease an external incision is absolutely essential.

If the whole of one side is to be removed, an incision is made, reaching from just below the red margin of the lip downwards to a point immediately below the symphysis, and thence along the under surface of the body of the jaw as far as the angle; it is then prolonged upwards as far as the posterior border of the vertical ramus, not extending further than the attachment of the lobule of the ear, so as to avoid the facial nerve (Fig. 241). When a large tumour is being dealt with, the whole thickness of the lip should be divided, and the flap thus marked out dissected off the bone, and turned outwards. Where, however, the upper portion of the lip is left, the incisions are carried down to the bone, the facial vessels being secured above and below before division. The soft parts are then freed from the outer aspect of the bone, and the cavity of the mouth opened. The central incisor tooth is drawn, and the jaw divided through the empty socket with a saw and cutting pliers. By this means the genial tubercles and their attached muscles are not encroached on, and the movements of the tongue are left unimpaired. The bone is seized and drawn outwards, so that its internal connections as far as the angle may be divided. It must then be firmly depressed, and the muscular attachments of the masseter on the outer side, and the internal pterygoid on the inner, cut through. The inferior dental nerve and artery will also be met with at this stage. By still further depressing the bone, the temporal tendon is exposed and should be divided by successive touches of the knife, which is kept close to the bone. Finally, the condyle is freed after division of the external pterygoid muscle and the ligaments of the temporo-maxillary articulation. The proximity of the internal maxillary artery to the inner aspect of the neck of the bone must be remembered, and hence it is important to keep the blade of the knife directed towards the bone. After hæmorrhage has been arrested, the wound is stitched together and dressed with collodion and gauze; possibly a drainage-tube may be inserted with advantage for a few days through the floor of the mouth. Considerable deformity usually results from this operation, owing to the remaining half of the bone being drawn across the middle line.

Diseases of the Temporo-Maxillary Articulation.

This joint is liable to all the various forms of disease common to articular cavities.

Acute Synovitis may supervene in the course of an attack of rheumatic fever, and is evidenced by pain on movement of the jaw, with swelling due to a serous effusion into and around the joint. Resolution is the usual termination, but fibroid thickening of the ligaments and impairment of movement may result.

Acute Arthritis arises from pyæmic infection after the exanthemata, or from gonorrhœa, but may be caused by direct extension of inflammation from the middle ear, as in scarlatina. It occurs in children, and is due 'to the persistence of a hiatus in that part of the tympanic plate which forms the floor of the meatus and the roof of the articulation' (Barker). It is characterized by the usual signs of a severe localized inflammation, with the formation of abscesses, and results commonly in ankylosis. Rest and the antiseptic opening of abscesses constitute the only early treatment, although excision of the condyle is sometimes required at a later date.

Osteo-Arthritis Deformans is by no means a rare affection of this joint. It is often symmetrical, and characterized by an enlargement of the condyle, which can be felt distinctly in front of the tragus, especially on opening the mouth, when crepitus is also noticed. The pain is worse at night and in wet weather, and the jaw becomes deflected to one side if the disease is unilateral; when both sides are affected, the jaw is pushed forwards, and the chin projects. The articular cartilages undergo the usual changes, and the glenoid cavity becomes enlarged and flattened, so that the eminentia articularis is relatively less marked, thus permitting the external pterygoid muscles to draw the condyles forward. After a time, considerable difficulty is experienced in opening the mouth, even amounting to ankylosis. Ordinary medical *treatment* may be used in the early stages, but in the later the condyle of the jaw should be excised, a proceeding followed by excellent results.

Tubercular Disease may arise either in the bone or synovial membrane, perhaps spreading to it from neighbouring lymphatic glands. It runs the usual course of the disease, terminating in caries of the condyle, and ankylosis after protracted suppuration; to prevent this, excision of the condyle is indicated.

Immobility or Closure of the Jaw may be caused by a variety of conditions:

1. True ankylosis of the temporo-maxillary joint, fibrous or osseous, as the result of any of the diseases mentioned above.

2. Cicatricial contraction of the soft structures either within or without the mouth, as from burns, lupus, or extensive operations in the pterygoid regions upon the roots of the fifth nerve, or from cancrum oris.

3. Spasm of the muscles of the jaw (or trismus), due to reflex irritation, as from carious teeth, or an unerupted wisdom-tooth, or some other local lesion. It is occasionally hysterical, and is one of the early symptoms of tetanus.

4. Local inflammatory conditions rendering opening of the mouth impossible, both from the pain and swelling—*e.g.*, in mumps, parotid abscess, acute alveolar periostitis—whilst in epithelioma and various forms of tumour the size of the growth may render the patient unable to open his mouth.

The term ankylosis can only be applied to the conditions mentioned in the first two groups. In the others appropriate treatment must be instituted according to the character of the affection. Where the closure of the jaw is permanent, it may be due to osseous ankylosis, the bony masses extending not only between the articular surfaces, but also between the alveoli, or to fibrous adhesions within the joint, or to extra-articular contraction of the soft parts, the skin and mucous membrane being not only involved, but also frequently the muscles and deeper structures.

Division of the neck of the bone may thus be impracticable, or, even if possible, is useless, since the muscles of the jaw hold the surfaces in such good apposition as to bring about a recurrence of bony union. Division of the intra- or extra-buccal cicatrices is unsatisfactory, owing to their rapid re-formation. The best *treatment* in such cases is either removal of the vertical ramus of the jaw down to the level of the alveolus, or the plan suggested by Esmarch, viz., excision of a wedge of bone, with its apex towards the alveolar border, from the neighbourhood of the angle, and the establishment of an artificial joint at that spot. The incision should be made below and behind the angle down to the bone from which the periosteum is stripped up, and division is accomplished by means of the saw.

Excision of the Condyle of the Jaw is by no means a simple operation in all cases, since the space at the surgeon's disposal is very limited, owing to the presence of the zygoma above, of the facial nerve below, of the parotid gland in front, and the external ear behind. The best incision is a curvilinear one, commencing over the middle of the zygoma, and passing downwards in front of the tragus. It should merely divide the skin and subcutaneous tissue, and the flap thus marked out is turned forwards. A transverse incision is now made through the deep fascia immediately below the posterior extremity of the zygoma, extending down to the neck of the bone, which is cleared by a raspatory and divided by cutting pliers; the condyle is then grasped with necrosis forceps, and twisted out. But little bleeding occurs, and the wound heals by first intention except along the track of the drainage tube, which should always be employed.

CHAPTER XXIII.

AFFECTIONS OF THE NOSE AND NASO-PHARYNX.

Affections of the Outer Nose.—Several forms of **Injury**, including fracture of the nasal bones and separation of the cartilages, have been already noticed (p. 378), and no further attention need be directed to them.

Depression or Flattening of the Bridge of the Nose is either a result of traumatism, such as a fracture of the nasal bones, or may arise from defective growth of the ethmo-vomerine septum, due to disease either of syphilitic or tubercular origin early in life, whilst it may also result from similar conditions occurring in the course of tertiary syphilis. If caused by injury, and dealt with promptly, it may be remedied; but when once acquired, and especially if the consequence of disease, nothing can be done from outside to restore the nose to its normal shape, although the use of a celluloid bridge fitted to the interior may to a large extent diminish the deformity. The frames have to be made specially for every case, and must fit accurately, or they will give rise to serious mischief.

Expansion of the Bridge of the Nose is always the outcome of some long-continued intranasal pressure, especially from the growth of polypi. It rarely follows the development of mucous polypi, except when they are very large and chronic, but it is not an uncommon accompaniment of the fibrous or fibro-sarcomatous variety. The bridge is flattened and bulged out on either side, giving the face a frog-like appearance; hence the name, 'frog-nose' which has been applied to it.

It is impossible to discuss all the different affections of the **skin of the nose.** Many of them are associated with the sebaceous glands, which in this region are very large and abundant. Thus, *acne* is very commonly met with, arising from an inflammation of the glands after obstruction to their ducts. It is especially frequent in drinkers and dyspeptics, women addicted to tea-drinking often suffering severely. When the superficial capillaries become markedly dilated and the face readily flushes on the imbibition of hot or stimulating fluids, the term *rosacea* is attached to it, whilst if acne pustules are also present, it is known as *acne* *rosacea.* Sometimes the spots become much enlarged, and there is a considerable amount of infiltration of the base, a condition described as *acne hypertrophicum.* In the most exaggerated stage the sebaceous glands become overgrown and form large protuberant nodular masses projecting from the end of the nose, and covered with red greasy skin, in which the dilated orifices of the glands are very evident, and with dilated capillaries coursing freely over it. This condition is generally known as *lipoma nasi*, *rhinophyma*, or *hammer-nose* (Fig. 244). The **treatment** of simple acne consists in correcting the dyspepsia, and limiting the amount of, or interdicting entirely, alcohol or tea. Capsules of ichthyol (3 to 10 minims), may also be administered thrice daily, and soothing applications should be used locally, such as a lotion consisting of calamine, oxide of zinc and precipitated sulphur, held in suspension with glycerine and lime-water. A solution of ichthyol is also sometimes beneficial. Dilated and unsightly capillaries may be dealt with by puncturing them with the galvano-cautery or an electrolysis needle. Rhinophyma requires operative proceedings; the protuberant mass should be freely dissected away from the cartilages, and the raw surface either left to cicatrize, or dealt with by Thiersch's method of skin-grafting.

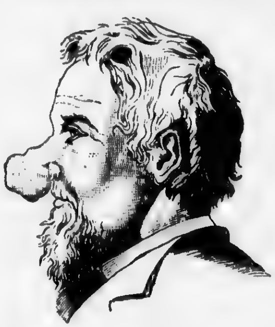

FIG. 244. — RHINOPHYMA, OR HAMMER-NOSE. (TILLMANNS.)

Partial or Total Destruction of the Nose may result from traumatism, but usually from some chronic inflammatory or malignant growth, such as lupus, tertiary syphilis, or rodent ulcer. Epithelioma sometimes attacks it, and requires total removal of the nose for its cure. In any of these conditions the resulting deformity is so repulsive that the surgeon is certain to be asked to undertake some proceeding to remedy it. Various plastic operations have been devised, which, however, we can only indicate briefly here, referring students to larger works of operative surgery for fuller details.

The chief methods of **Rhinoplasty** are as follows:

1. The so-called *Indian method* consists in the formation of a nose from a flap of skin obtained from the forehead. The flap (Fig. 245) is more or less pyriform, with the pedicle so placed as to contain one of the frontal arteries and the supratrochlear nerve. The frontal periosteum may or may not be included in the thickness of the flap, which is twisted round and applied to the refreshed margins of what remains of the nose (Fig. 246). Beneath the free end of the flap two portions of rubber or celluloid tube are inserted, so as to form the anterior nares, and the columna is constituted either at the time or subsequently by turning up the centre of the upper lip, and uniting it to the

under surface of the flap. When the union of the lower portion is sufficiently firm, steps are taken to make the nose more shapely by partially dividing the twisted pedicle, but if possible the integrity of the frontal artery should still be retained. The wound in the forehead is partially closed by sutures, and healing promoted later by skin-grafting.

2. In the *Tagliacozzian or Italian operation* (so called from Tagliacozzi, the surgeon who first proposed it) a flap of skin is taken from the upper arm. The pedicle must always be broad, and is left attached to the upper part of the inner aspect of the upper arm; it must be so placed that it can be brought into apposition with the nasal defect without tension, the forearm and hand being fixed by a suitable apparatus above the head, and retained there until good union has been accomplished. All that is desired at first is to obtain union, and as this is consolidated the pedicle is gradually divided. Absolute fixation of the arm is an essential, and as this may need to be maintained for two or three weeks, the patient needs a considerable amount of pluck and perseverance. When the pedicle has been detached, subsequent plastic measures are required to mould the new tissue to the shape of the nose.

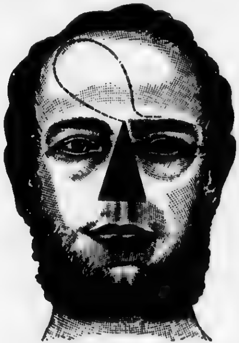

FIG. 245.—INDIAN METHOD OF RHINOPLASTY, SHOWING THE SHAPE AND POSITION OF THE FOREHEAD FLAP. (TILLMANNS.)

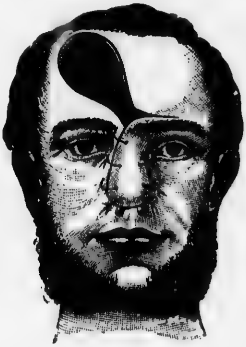

FIG. 246.—FLAP STITCHED IN POSITION. (TILLMANNS.)

3. The cheeks have also been made use of in what is known as the *French method* to supply material for the nose, flaps being dissected up from either side, and united in the middle line.

The above operations have the great objection that the new nose only consists of soft tissues, and hence is extremely liable to shrivel up and contract, so that all that is finally obtained is a covering for the defect which is often quite flush with the surface. To obviate this, and to secure a bony basis for the nose, attempts have been made to utilize a finger for the purpose, and Mr. Astley Bloxam has had one or more most successful cases. The terminal phalanx is removed, the soft parts split down the middle line on the palmar aspect, and the divided segments united by suture to the margins of the nasal defect. When union is secured, the amputation of the finger is completed.

Naturally, where only a portion of the nose is destroyed, partial operations can be devised to meet the requirements of the case.

Examination of the Nose and Naso-Pharynx.—In order to understand fully the diseases of the nose, it is essential that the interior of the organ be efficiently examined, and to do this three chief methods are resorted to:

1. *Anterior rhinoscopy* consists in the illumination of the front of the nasal cavity through the anterior nares. A good light is required, such as that derived from an electric head-lamp, and some form of nasal speculum. Perhaps Thudichum's speculum is one of the best; it consists of two unfenestrated blades, connected by a U-shaped spring, which is held in the hand, whilst the blades are inserted into the nostril, the nasal vibrissæ being thus held aside; the ring and index fingers are placed one on each limb, so as to regulate the amount of tension, and thus prevent painful overstretching. By this or similar means one is enabled to see the anterior part of the nasal fossæ, including the inferior turbinated bone, and the erectile tissue at its anterior extremity. The amount of distension of the latter limits the view of other structures; if greatly swollen it feels soft and even fluctuating, but collapses entirely on the application of a 5 per cent. solution of cocaine, allowing the free convex border of the middle turbinated bone to come into view, as also the cleft or olfactory fissure between it and the septum. The septum can also be examined, showing frequently deviations from the middle line, and thickenings or spurs of bone or cartilage, which run in an antero-posterior or vertical direction. A certain amount of erectile tissue is also found on the septum.

2. By *posterior rhinoscopy* is meant an examination of the posterior nares by a mirror placed behind the uvula and soft palate. It is by no means easy to accomplish, and requires some dexterity and practice. The tongue should be depressed, and a small mirror, previously warmed to prevent condensation of moisture, is then passed behind the uvula, without touching it or the posterior wall of the pharynx, and by shifting its angle and position a view should be obtained of the structures exposed posteriorly. If not successful, and it is absolutely necessary to obtain a view, the fauces should be cocainized and the velum held up by some form of palate retractor, such as White's. The posterior nares (or choanæ) are seen, separated by the vertical posterior free margin of the septum, and within each cavity the rounded ends of the turbinated bones with the meatuses intervening. The inferior meatus often looks very small owing to the prominence of the velum palati, whilst the middle meatus may be encroached on by the tumefaction of the erectile tissue at the back of the inferior spongy bone. Outside the choanæ are seen the yellowish openings of the Eustachian tubes, whilst above and between them Luschka's tonsil, a raised collection of lymphoid tissue in the roof of the pharynx, may be occasionally observed.

3. *Palpation of the posterior nares*, with the index finger, previously disinfected, will, however, give better results in the

majority of cases to those who are not specially practised in the above method. The index finger is passed behind the uvula and velum, and the nares can then be well explored, and the existence of adenoids or other growths determined.

Foreign Bodies are rarely impacted in the nasal passages except in children, in whom the condition is not uncommon. Any unilateral purulent discharge from a child's nose should suggest the likelihood of such an occurrence, peas, beads, or buttons, being the substances usually introduced. A certain amount of unilateral obstruction to nasal respiration is caused thereby, followed by a catarrhal or even suppurative rhinitis. As a rule, removal is readily effected by syringing out through the unaffected nostril, the lotion rushing back through the other side, and carrying the intruding body before it. Failing this, the child should be anæsthetized and a forceps or scoop employed, the surgeon's manipulations being guided by a rhinoscope and frontal illumination. Necessarily, all instruments used for this purpose should be thoroughly sterilized. After the removal, the nostrils are carefully washed out for a few days with a weak alkaline antiseptic lotion, such as salt and water to which a little sanitas has been added.

Acute Rhinitis.—Several distinct varieties of this affection are described.

1. The **Catarrhal** form is extremely common, constituting what is popularly known as a 'cold in the head.' Not only is the nasal mucosa affected, but the inflammation often extends to the frontal sinuses or antra, causing brow-ache and face-ache, whilst if it spreads to the mucous lining of the Eustachian tube, temporary deafness may ensue. In infants great dyspnœa may be caused owing to the extreme narrowness of the nasal passages, and this may be so marked as to interfere for a time with breast feeding. Apart from the usual domestic remedies directed to increasing the action of the bowels, kidneys, and skin, considerable relief can often be obtained by washing out the nasal cavities three or four times a day with a weak warm alkaline lotion containing borax and possibly a little menthol.

2. A **Suppurative** form may also arise from gonorrhœal infection either in adults or infants, but perhaps more commonly in the latter. The discharge is abundant, and causes much obstruction to nasal respiration, whilst ulceration is likely to occur. The passages must be well cleansed with a solution of boric acid several times daily, and the interior painted with a weak solution of nitrate of silver once every day as long as the suppuration continues.

3. True diphtheria also occurs in the nasal fossæ, usually as a complication of the same disease elsewhere, and requiring a similar form of treatment.

Chronic Rhinitis.—So many distinct types of chronic inflammation of the interior of the nose have been differentiated of late years that it is impossible for us to give more than the barest outline of them. For fuller details we would refer readers to Dr. Greville Macdonald's excellent work on diseases of the nose.*

One of the forms most commonly met with is characterized by engorgement of the erectile tissue covering the inferior turbinated bone, causing considerable obstruction to nasal respiration and an abundant discharge of muco-pus. It usually occurs in patients with long, prominent noses of the Jewish type, where the nasal passages are narrow, and in consequence the air pressure is diminished; it may be lighted up by some slight local irritant, such as a sudden change of temperature. The anterior end of the inferior turbinated bone is swollen, red, and rounded, the mucous covering being œdematous, and the mass feeling, on touching it with a probe, like a sac full of fluid. The local application of a 5 per cent. solution of cocaine causes its complete, though temporary, collapse in a few moments. If it is allowed to persist, hypertrophy of the mucous membrane follows, and in the most marked types a projecting papillomatous-like mass, almost resembling a polypus, may result. It is, however, merely an inflammatory hyperplasia, and not a new growth; papillomata of the nose are so rare as to be almost unknown. The posterior end of the bone may be similarly affected, and the mucous covering of the middle turbinated may participate in the same process. A certain amount of pharyngitis or laryngo-tracheitis may also be present. **Treatment.**—In the early stages all that is required is to wash out the nasal cavity night and morning with some simple nose lotion, such as borax or bicarbonate of soda (5 grains to 1 ounce). This may be accomplished either by sniffing the solution from the palm of the hand, or by using some form of nasal douche; Basdon's douche is perhaps the best for this purpose. If such is insufficient to give relief, or if collapse is not produced by cocaine, the surface may be swabbed over with some diluted caustic, or, better still, a point of galvano-cautery at a red heat may be run along the length of the bone. In the later stages removal of the hypertrophied excrescences by the cold wire snare, or by the galvano-écraseur, is required.

Another group of cases of chronic rhinitis is associated with collapse of the erectile tissue, and then there is but little discharge, since the exudation dries within the nasal cavities and forms inspissated crusts or scabs which are often difficult to remove. The nasal fossæ are in this case more patulous than usual, and a dry pharyngitis and chronic laryngitis often accompany it. Luschka's tonsil may also be enlarged at the same time. Both nostrils may be affected in this condition, but occasionally it results from deviations of the septum, and then is unilateral, the discharge coming from that side which is most patulous, whilst the narrowed side remains healthy. When symmetrical, the disease is rather due to constitutional than to local causes, occurring in weakly, anæmic women, and is to be treated by general rather than local measures. In the unilateral form, deviations of the septum from the middle line must be rectified, or excrescences removed, and for this purpose many different instruments have been suggested. In this way the inspired air is made to pass more freely along the narrowed healthy side, and the other nostril is dealt with by the use of weak alkaline lotions. It may be also advisable to plug the dilated side with cotton-wool for some time daily, so as to enforce respiration through the other nostril. Treatment is always likely to be prolonged, and it is possible that a daily alkaline nose lotion may be needed permanently. Stimulating applications are never borne well, and hence should rarely be ordered.

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* 'Diseases of the Nose,' Alex. P. Watt and Son. Second edition, 1892.

Ozœna.—This term was formerly applied to any offensive muco-purulent discharge from the nostrils, whatever the cause, and thus was made to include such conditions as tubercular or syphilitic disease of the turbinated bones or of the septum, the impaction of foreign bodies, or the ulceration of malignant growths. It has now, however, been limited to one particular affection, and that a special form of rhinitis sicca.

The disease is usually met with in young females, and may sometimes originate from some traumatism, or after one of the exanthemata, or is associated with inherited tuberculosis or syphilis. The nose is almost always wide and roomy, and may be of the special strumous type; the lips are often thick and everted, and the mouth is usually held open owing to the impediment to nasal respiration caused by inspissated mucus. The fœtor of the breath is the special feature that calls attention to the complaint; it is peculiarly searching and objectionable, but the patient fortunately is not usually cognizant of it. It is due to the decomposition of the muco-pus collecting in the nasal cavity, and although Lünenberg's diplococcus is constantly present, the causative organism has not been determined with certainty. There is not much discharge, but at varying periods large crusts come away, giving relief both to the nasal respiration and to the fœtor. Both nostrils are usually involved alike.

On examination, the shape and size of the nares are the first things that claim attention; vibrissæ are apt to be scanty, and on inserting a speculum the unusual patency becomes evident; in fact, after clearing away all the dried mucus and scabs, it may be easily possible to see the posterior pharyngeal wall, and even the orifices of the Eustachian tubes. The mucous membrane over the turbinated bones is dry, collapsed, and pale, and crusts may be found covering any or every part of them. The pharyngeal wall is also dry, and may be coated with a film of inspissated mucus. No ulceration is, as a rule, present, although the removal of the crusts may be associated with a slight amount of bleeding owing to their close attachment to the mucous membrane.

As to **Ætiology**, it is important to note that ozœna is never seen in patients with stenosed and narrow nostrils, and is almost always associated with wide, roomy noses. In consequence, it is difficult to obtain sufficient air pressure within them to expel the exudation arising from any ordinary rhinitis, and hence the discharge tends to collect and necessarily to putrefy. The irritation thus induced is likely in weakly children to lead to suppuration. For the same cause the mucous membrane tends to dry and the erectile tissue to collapse, so that an atrophic form of rhinitis sicca results, followed in time by sclerosis and shrinking of the turbinated bones. It is always a prolonged process, although in the course of years it tends to improve and gradually disappears.

Treatment.—The first essential is to keep the nose clean and free from putrefying masses of dried secretion. This must be accomplished by irrigating the cavity once or twice daily, and preferably with warm water, to which a little alkali, such as common salt, and an unirritating antiseptic, such as sanitas, has been added. At first it is well for the surgeon to see to this himself, but after a while the patient or her friends can be entrusted with the task. Every portion of scab ought to be removed daily, and the surface lubricated with some such application as a spray of menthol and paroleine (10 grains to 1 ounce). The nose should then be partially plugged with a tampon of cotton-wool, especially along the lower meatus, and if thought desirable the wool may be medicated with some antiseptic. By this means a flow of mucus from the membrane is determined, and the discharge is thus rendered more fluid, and inspissation prevented. A similar end may also be obtained by partially plugging the nostril with an indiarubber tube, so as to diminish its size. The general health must be attended to, and as a rule patience and perseverance will at length be crowned with success. Operative measures are scarcely ever called for in this disease, although they have frequently been resorted to most unnecessarily.

Disease of the Middle Turbinated Bone and Ethmoid is sometimes the cause of an offensive purulent discharge from the nose, which is often wrongly called ozœna. It may occur in individuals of all ages and classes, arising from syphilitic or tubercular disease, but is perhaps most commonly due to septic infection from without, the result of meddlesome and careless surgery. It must be remembered that the upper part of the nose is practically aseptic, and the introduction of dirty instruments is often responsible for this affection. It commences as a submucous infiltration, usually of the middle turbinated bone, and thence spreads, with or without ulceration, to the periosteum covering the bone, which becomes carious or necrosed. Various parts of the ethmoid, including the cribriform plate, may also be involved, and the adjacent bony cavities (antrum, frontal and ethmoidal sinuses, etc.) may become filled with pus. In bad cases the venous channels in the base of the skull—*e.g.*, the cavernous sinus—may be thrombosed and infected, and even abscess of the brain has followed. One or both sides of the nose may be affected, perhaps most frequently but one. On examining the interior of the nostril, there is no patency of the cavity, as in ozœna, but a large polypoid mass of granulation tissue may be seen blocking the middle meatus and covered with a half-dried scab, whilst pus can be seen to exude from a hollow in the midst of it when pressed upon; this usually comes from the antrum or frontal sinus, a mass of granulation tissue lying both above and below the entrance. A probe passed into the mass always impinges on diseased or bare bone.

When due to syphilis, distinct sequestra are usually met with, sometimes involving the septum and hard palate, but the accessory cavities are not, as a rule, invaded.

The **Diagnosis** from ozœna is made by remembering that in the latter the characteristic features are the abnormal width of the nasal fossæ, the bilateral symmetry, the collapse of the erectile tissue, the more complete inspissation of the secretion, and the pathognomonic stench, which are all absent in these cases. A certain amount of odour is present, but it is mainly noticed by the patient, not so much by outsiders.

Treatment consists in the removal of all dead and carious bone that can be safely dealt with, together with the destruction of all fungating granulation tissue, and the drainage of such accessory cavities as can be reached, whilst attention is given to maintain cleanliness and asepsis as far as possible. Thus, the middle turbinated bone and its accompanying mass of granulation tissue may be removed by the sharp spoon, snare, or polypus forceps. The antrum must, if necessary, be opened and drained, and the walls of the ethmoidal cells may be broken down, and exit thus given to pus. The greatest gentleness and care must be exercised when any attempt is made to deal with the roof of the nose.

Nasal Polypi.—Two forms of nasal polypus are described, viz., the simple or mucous polyp and the fibrous or fibro-sarcomatous. Other malignant tumours occur in the nasal fossa, to which, however, the term polypus can scarcely be extended; they mainly originate from the superior maxilla.

The **Mucous Polypus** consists of a soft gelatinous mass, which on microscopic examination much resembles myxomatous tissue, covered by ciliated columnar epithelium, and supplied freely with bloodvessels. There has been a good deal of discussion of late as to whether or not these polypi are really of a myxomatous nature, but the general opinion of rhinologists is in favour of the view that they are inflammatory in origin, consisting merely of œdematous hypertrophic tissue. The growths are usually situated on the middle and superior turbinated bones. They rarely start from the roof of the nasal fossæ, occasionally in the sinuses, or at the orifices leading into them; they hardly ever involve the septum or inferior turbinated bone. The polypoid masses are generally multiple, a large one projecting downwards and forwards towards the anterior nares, and covering or hiding a whole series of smaller ones, which readily spring into prominence when that in front is removed. They are sometimes dependent on, and kept up by, suppuration in one of the adjacent sinuses. They are usually attached by but a small pedicle, and in shape they are pyriform, and laterally compressed, owing to the narrow space in which they develop. When of large size, they may protrude through the nostrils, and then the epithelium covering the anterior portion becomes squamous, and the whole mass firmer in texture and papillomatous in appearance. Sometimes they project backwards into the pharynx, and are more distinctly globular and usually single. Occasionally they are the starting-point of a myxo-sarcomatous growth, which develops rapidly, and early tends to invade the surrounding bones.

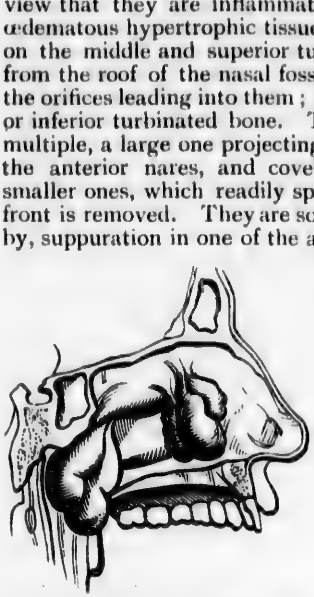


FIG. 247.—MUCOUS POLYPI OF NOSE, SPRINGING FROM THE BACK AND FRONT OF THE MIDDLE TURBINATED BONE.

The main **Symptom** arising from nasal polypi is obstruction to the passage of air along one or both sides of the nose, according to the location of the growths. This is always of gradual onset, and is invariably worse in wet weather, on account of the hygrometric property of mucoid tissue. There is often a watery or mucoid discharge from the nose, which may perhaps be blood-stained. The patient is unable to blow the nose, and his articulation becomes nasal in quality. On rhinoscopic examination one finds a grayish semi-translucent glistening mass occupying the nostril, and attempts to blow the nose render this more obvious. Its pedunculated nature can be easily demonstrated by passing a probe around it. When of large size, some flattening or expansion of the bridge of the nose may be caused thereby, and possibly epiphora from pressure on the opening of the nasal duct in the middle meatus.

The **Diagnosis** should present no difficulty to one who knows how to employ the nasal speculum. Abscess or deviation of the septum, though causing unilateral obstruction, is recognised by the exercise of a very small amount of intelligence. Œdematous masses of granulation tissue, associated with tubercular or syphilitic disease of the bones, are known by usually involving the septum as well as the turbinated bones, by the purulent discharge, by the absence of superficial epithelium, and by not being distinctly pedunculated; carious bone can usually be felt by a probe through the granulation tissue. From hypertrophy of the mucous membrane over the inferior turbinated bone, a polypus is known by the fact that it scarcely ever springs from this region, whilst the former condition is sessile, red, and diminished considerably in size by the application of cocaine.

The **Treatment** of mucous polypi consists in their removal either by forceps or the snare. The former plan is usually condemned by rhinologists as unscientific and barbarous, and as utilized by many of the old class of surgeons, such it certainly was; but if employed in the way described below, it is just as efficient as the snare, and gives the patient very little, if any, more pain. Personally, we must plead guilty to a very distinct preference for the forceps.

In undertaking avulsion by forceps, the patient is seated in a chair, and the surgeon sits or stands in front of him. The nasal cavities are fully cocainized, and the situation of the pedicle ascertained as clearly as possible by illuminating the interior, and by the use of a probe. The forceps employed should be long, with delicate, though strong, blades, which are deeply serrated on either side of a median groove. They are introduced open, with a blade placed horizontally on either side of the growth, and are gently pressed upwards until the pedicle is grasped as close to the turbinated bone as possible. The blades are then closed firmly, and the polypi twisted off and removed, a certain amount of hæmorrhage resulting. The same process is repeated to the smaller tumours until the nostril is clear. It may be plugged with a strip of boric lint if the bleeding continues, but such should never be left unchanged longer than twenty-four hours. The plug is then removed, and the base of the growth carefully examined and cauterized with the galvano-cautery by the aid of a nasal speculum. This cannot be so accurately accomplished immediately after removal, as the bleeding interferes with clear vision. The cauterization of the base is a most important item in the treatment, as without it the growths are sure to recur. The patient should be again examined after a short interval, so that any smaller polypi which have commenced to develop may be suitably dealt with.

To remove polypi with the galvanic ecraseur or snare, a speculum is inserted, and the wire loop passed round the growth so as to encircle its base, and gradually tightened until it has cut through. This plan is specially adapted to large masses which project downwards behind the palate.

Whichever method be adopted, recurrences are not uncommon, and the treatment may in consequence be very prolonged; but if the surgeon will persevere in the way described above, the disease can in time be eradicated without having recourse to such a mutilating procedure as removal of the turbinated bones; indeed, after such an operation, considerable trouble may arise from the nasal cavity being too patulous.

A **Fibrous Polypus** is the term applied to a fibroma, which tends sooner or later to become sarcomatous, springing from the base of the skull, especially from the basi-sphenoid or basi-occipital. It is at first distinctly pedunculated, and is usually firm, smooth, and fleshy in character; when of large size, it may be lobulated. The early symptoms are almost limited to those of obstruction to nasal respiration, but to this is not unfrequently added severe epistaxis, owing to the vascularity of the capsule and of the overlying mucous membrane. As it increases in size, ulceration occurs, leading to a fœtid sanious discharge, and the growth rarely remains limited to the nasal fossæ. If pushing forwards, it may lead to expansion of the bridge of the nose and separation of the eyes, which may even be made to diverge; but if backwards, it may depress the velum, and hang downwards as a naso-pharyngeal tumour. In other cases it may force its way into the orbit or any of the other surrounding cavities, or may even erode the base of the skull, and encroach upon the cranial cavity. It is rare for any of these latter manifestations to occur until after the tumour has taken on a distinct sarcomatous type.

The disease usually attacks young people, and mainly those in the second decade of life. It progresses with considerable rapidity, and the fatal issue may be due to hæmorrhage, asphyxia, or cerebral complications.

Treatment.—Unfortunately this condition is but rarely recognised in the early stages, owing to the fact that the majority of practitioners are quite unable to use the rhinoscope. We would impress upon students the immense importance of thoroughly exploring both by the mirror and the finger passed behind the velum every case of nasal obstruction or of chronic discharge from the nose. When the growth is small and polypoid, it can often be dealt with from the anterior nares by means of a galvano-écraseur. The wire loop is inserted from the front, and hitched over the tumour, so as to encircle its base, by the assistance of the right index finger passed behind the velum. The pedicle must be divided as near the skull as possible, as otherwise recurrence is almost certain to follow. Possibly Nélaton's operation, described below, would in some instances assist the surgeon in reaching the base of the skull, and dealing with the tumour.

In the more severe cases, where the growth has become diffuse, it is very doubtful whether much good can be done by operation, since the base of the skull is sure to be gravely affected. If treatment is attempted, one or other of the many plans for exploring the nose or naso-pharynx must be resorted to, and the operative measures must be modified according to the peculiar requirements of the case. Probably total ablation of the superior maxilla will give the best approach to the mass.

Other forms of **Malignant Disease of the Nose** are met with, and may originate in any part of the nasal fossæ. **Squamous epithelioma** is that which occurs most frequently; the symptoms consist in the presence of a blood-stained discharge, and a certain amount of respiratory obstruction, together with pain and cachexia. The lymphatic glands at the angle of the jaw are early enlarged, and the course of the disease is usually rapid owing to the great vascularity of the part. Up to within quite a recent period such growths have been almost always looked on as inoperable, but within the last ten years attempts have been made to remove them, and although necessarily the mortality is great, and the liability to recurrence considerable, yet the results have been such as to encourage the practice of attacking the disease, even in such a difficult region to explore as the interior of the nose.

Sarcoma may also commence in the nose itself, quite apart from that which originates in the superior maxilla. It gives rise to the usual signs of an intra-nasal growth, and may be dealt with in a satisfactory manner by local means, such as curetting and the application of caustics. Not a few cases are on record in which such treatment has proved efficacious in curing the disease.

The **operations** which have been devised *for dealing with disease of the naso-pharynx* are so numerous and complicated that it is impossible for us to mention more than a few of the more useful and important.

(*a*) In many cases of intranasal disease considerable assistance can be derived by *opening up the anterior nares*, especially when one is operating for caries or necrosis of the turbinated bones. It may suffice to merely divide one ala nasi and the attachments of the cartilages to the maxilla; but where both sides are involved, *Rouge's operation* is advisable. This consists in detaching the mask of the face from the maxillæ by everting the upper lip, and incising the mucous membrane and subjacent tissues until the nasal cavities are opened. The septum nasi is divided by cutting pliers, and the nasal cartilages completely detached. The soft tissues of the face can then be retracted upwards, and the nasal fossæ fully exposed. The bleeding is always considerable, and the space gained in children is but slight. When the operation is completed, the mask of the face is allowed to fall back again into position, union occurring without difficulty, although no sutures are employed.

When the upper and anterior portion of the nasal cavity is to be dealt with, Langenbeck's plan can sometimes be utilized with advantage. An incision down to the bones is made along the outer border of the nose from the root downwards and outwards towards the ala. The soft parts are retracted on either side so as to expose the nasal bone and the nasal process of the superior maxilla, a wedge-shaped portion of which can be divided by cutting pliers and prised upwards, but left with their superior connections untouched, so that after the operation they can be replaced.

When the septum alone is involved in malignant disease, it is possible to deal with it by an operation, which consists in splitting the upper lip in the middle line, and carrying the incision round the ala nasi on each side so that the lower portion of the nose can be turned upwards after dividing the septum. A wedge-shaped portion is then removed from the front of the palate after detaching the muco-periosteum from its buccal aspect. An excellent approach is thus obtained into the nasal cavity, and the entire septum can in this way be removed without difficulty. The parts can be afterwards brought together quite naturally, and the deformity is very slight.

(*b*) When the disease is located further back, originating rather in the naso-pharynx than in the nose itself, the *palatine route* may be used with advantage. Perhaps the best of the several suggested operations is that of *Nélaton.* This consists in a median section of the velum and of the mucous membrane covering the posterior half of the hard palate. A transverse incision is then made on either side of the anterior extremity of this, and two muco-periosteal flaps reflected, exposing a quadrilateral area of bone which is removed by chisel and mallet. If need be, part of the vomer is also taken away, and thus the naso-pharynx is opened sufficiently to allow of the removal of the polypus or growth. The reflected segments of the palate are subsequently sutured together.

(*c*) Various methods of *osteoplastic section of the superior maxilla* have been practised, and Langenbeck's name has been associated with one or two distinct plans, which are, however, only suited to particular cases of disease, and at best give but poor access to the parts behind or above the superior maxilla, whilst they usually leave extremely obvious cicatrices. Perhaps the best plan to adopt in any such case is to temporarily detach the superior maxilla from its bed, turning it outwards together with the cutaneous and subcutaneous tissues overlying it, and then, after completing the operation, replacing the bone and suturing the soft parts into position. The results of such practice have been extremely encouraging.

Adenoids.—About twenty years ago Meyer first drew attention to this condition; and yet at the present time it is not too much to say that a large proportion of children and young people are subject to it in a more or less aggravated form, and it is difficult to ascertain whether such is due to a real increase in the number of those attacked, or whether it is merely in consequence of special attention being directed to it. Adenoids are very common in children with an inherited tubercular history, and are of considerable importance from the results to which they give rise.

It has been already mentioned that the naso-pharynx is the seat of a large amount of lymphoid tissue, similar to that met with in the tonsil, and which may either be distributed widely over the whole mucous membrane, or may be gathered into a special mass on the roof, known as the pharyngeal or Luschka's tonsil. Adenoids consist in a chronic hyperplasia of this tissue, exactly analogous to the chronic hypertrophic form of tonsillitis, with which, indeed, it is often associated. They may occur in the form of broad cushion-like masses springing mainly from the roof or posterior walls, or occasionally as pedunculated tumours hanging down into the posterior nares. Fig. 248 represents such a condition as seen by posterior rhinoscopy. The tumours are extremely soft and vascular, bleeding very readily. Not uncommonly isolated masses similar in structure to the above are also to be seen on the posterior wall of the pharynx, and a certain amount of chronic rhinitis and laryngitis may be associated.

The **Symptoms** induced by adenoids are mainly due to obstruction to nasal respiration. The mouth is generally held half open, so as to allow the patient to breathe through it, and for a similar cause he snores during sleep, and usually wakes with the mouth and tongue dry. The nostrils are drawn in, and the nose thin and pinched, the whole aspect being very characteristic; the children often look half silly, and indeed may be very backward in their studies. Not uncommonly there is a certain amount of semi-purulent discharge from the nose, or it may be hawked up from the pharynx, perhaps mixed with blood. Deafness also results from a spread of the catarrhal condition to the mucous lining of the Eustachian tubes, and both taste and smell may be interfered with. In bad cases which have been allowed to persist throughout adolescence considerable deformity of the thoracic parietes is induced, owing to the inability of the child to take a really deep inspiration, the ribs in consequence being drawn in. The palate also becomes high and arched, owing to the defective intranasal air pressure, and if the patient grows up, the teeth may project forwards, giving a curious rabbit-like expression to the face. The cervical glands are often sympathetically enlarged, and may be the seat of tubercular disease.

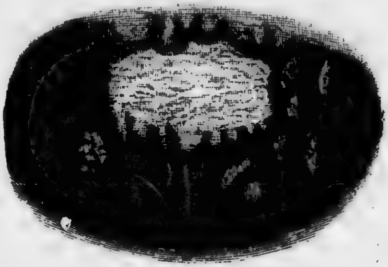


FIG. 248.—ADENOIDS AS SEEN BY POSTERIOR RHINOSCOPY. (TILLMANNS.)

Physical Examination consists in posterior rhinoscopy, by means of which the growths can be seen, or in palpation of the posterior nares, a process more suitable to children, who rarely have sufficient control to permit of the former. On passing the finger behind the velum, the naso-pharynx is found to be occupied by a soft mass of tissue which readily bleeds, and more or less obstructs the openings of the posterior nares.

Treatment consists in the great majority of cases in removal of the adenoids by operation. If left alone, there is a tendency for these growths to gradually disappear, but during this interval the development of the child may be considerably hindered, and hence a cure by natural processes in children should never be relied on. In young adults, however, attention to the general health, combined with irrigation of the nose with salt and water, and perhaps the local application of a weak solution of nitrate of silver (5 grains to 1 ounce) to the naso-pharynx, may suffice to bring about an amelioration of the condition.

Operation.—Much diversity of opinion exists as to the character and extent of the operation; some authorities consider that all that is required is to scrape the growths away with the finger-nail, and undertake this proceeding either under nitrous oxide gas, or even without an anæsthetic. Such a measure is, to our minds, unsatisfactory, in that the adenoids cannot possibly be entirely removed, and recurrence may ensue. As a general rule, the child should be anæsthetized with chloroform, and if enlarged tonsils co-exist, these should be dealt with in the first place. Löwenberg's forceps, curved so as to allow of them being passed behind the soft palate, are then introduced with the right hand, whilst the velum is protected by the left index-finger passed behind it. The protuberant masses are grasped and torn off, special attention being directed to clearing the posterior nares. The orifices of the Eustachian tubes are readily detected, and must not be injured. Care must also be taken not to lay hold of the uvula by mistake. The surgeon's finger-nail may be used to complete the removal of any tags of tissue that remain. Of course, there is considerable bleeding, but this quickly stops of itself, and as soon as the operation is over, the head should be turned to one side, or the child held face downwards, so as to allow the blood to run out of the mouth and nose. The after-treatment consists in washing out the nose and throat with either salt and water, or a weak solution of sanitas; the patient is kept indoors for a few days, and only fluid food allowed. Gottstein's curette is preferred by many rhinologists, but we see no advantage in it over the forceps recommended above.

Epistaxis, or bleeding from the nose, may arise from a variety of causes, including traumatism, directed either to the mucous membranes or the bones, or from the presence of ulceration or tumours. Some of these local causes are very evident, if only they are carefully looked for with a rhinoscope and frontal mirror. One of the commonest lesions is a small abrasion or ulcer of the septum, due to detaching by the finger a scab or dried crust of mucus which causes irritation within the nostril; each time the nose is 'picked' in this way, bleeding recurs. Another frequent source of epistaxis is the rupture of a varicose vein in the mucous membrane of the septum; varix occurs not unusually in plethoric individuals, and sneezing or blowing the nose violently may lead to an attack. Foreign bodies may also cause it, or ulceration of an angioma on the septum. It frequently occurs in young people about puberty in consequence of local disturbance in the vascular arrangement of the parts; again, cerebral congestion may induce it, owing to the communication by means of emissory veins between the interior of the skull and the venous plexuses in the nose; excessive changes in the atmospheric pressure, as in mountaineering, may lead to epistaxis, whilst in abnormal states of the blood it may be associated with hæmorrhage elsewhere, as in hæmophilia, purpura, and scurvy. One or both nostrils may be the seat of the bleeding, and it may be so excessive as even to threaten life.

Treatment.—It must not be forgotten that, in the majority of cases, there is some local cause of epistaxis which can be found and treated directly—a fact which once more emphasizes the necessity for gaining a mastery over the use of the rhinoscope. The bleeding is generally unilateral, and in nine out of ten cases the source is within easy reach of the anterior nares, and hence in many instances all that is required is to grasp the nostrils firmly, and thus allow the blood to collect within, and give it an opportunity of clotting. At the same time, the patient should sit up, and cold may be applied to the root of the nose, or to the nape of the neck. If on examination the bleeding point is detected, whether it be a varicose vein or an ulcerated surface, the hæmorrhage can almost at once be stayed by applying a pointed galvano-cautery, or by sealing the spot with a swab soaked in a solution of chromic acid. Failing these measures, the nostrils may need to be plugged, but such a proceeding ought to be seldom resorted to; it is practically a confession of want of

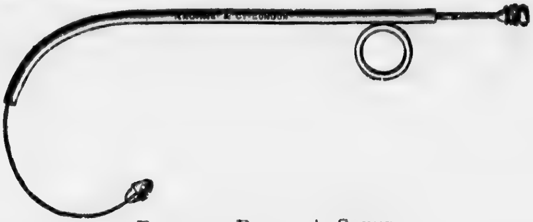


FIG. 249.—BELLOCQ'S SOUND.

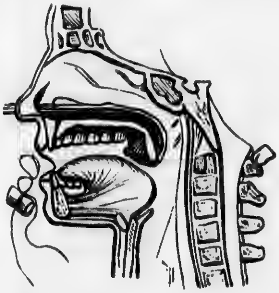


FIG. 250.—INTRODUCTION OF BELLOCQ'S SOUND.

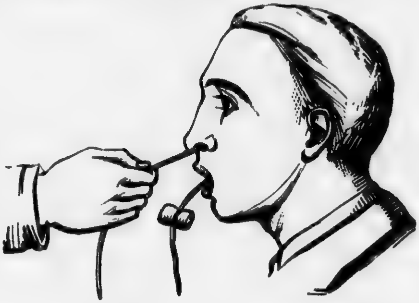


FIG. 251.—PLUG BEING INSERTED BY THE SAME.

skill in the use of the rhinoscope. It may suffice merely to plug the anterior nares by means of long strips of boric lint, but, as a rule, the posterior nares also require plugging. For this purpose Bellocq's sound (Fig. 249) is usually employed in order to pass a thread round the base of the palate, and out of both nose and mouth (Fig. 250); but where it is not obtainable, a suitably curved pair of laryngeal forceps or a catheter may be used instead. To the lower end of this thread a pledget of lint about 1½ inches by 1 inch in size is attached (Fig. 251), and this is guided by the finger round the soft palate, and drawn tightly forwards into the posterior nares, whilst the two ends of the thread are tied together round the upper lip to prevent it from slipping. The plug is retained for twelve hours, and then removed, and the nasal fossæ irrigated with a weak warm alkaline antiseptic lotion in order to prevent sepsis.

Another method of arresting epistaxis is by Cooper Rose's inflating plug; it consists of a piece of gum catheter, surrounded by a thin indiarubber bag, which can be inflated through the hollow stem. It is oiled and passed well into the nose from the front; the indiarubber bag is then inflated to the required extent, the air being retained by a stop-cock. This generally acts most efficiently, and can be both introduced and removed with scarcely any pain to the patient.

CHAPTER XXIV.

AFFECTIONS OF THE MOUTH, THROAT, AND ŒSOPHAGUS.

Stomatitis, or inflammation of the mucous membrane of the mouth, is by no means uncommon, especially in children.

1. **Simple Catarrhal Stomatitis** results from mechanical irritants, such as roughened teeth, from irritating chemicals, or from that septic form of inflammation which is so liable to follow operations involving the mouth. It may also arise in the course of fevers, and in conditions of debility such as follow measles and other exanthemata in children; or be associated with disturbances in the alimentary canal, as by improper feeding, dyspepsia, etc. The mucous membrane becomes hyperæmic and swollen, usually in small localized patches, which may gradually spread and become confluent, involving nearly the whole of the oral mucous membrane. The exudation of mucus is increased, and becomes viscid and turbid, whilst the epithelium, at first white and sodden, is after a while rubbed off, leaving superficial erosions or distinct ulcers, which are very painful. The *treatment* consists in the removal of all sources of irritation, and the administration of drugs which shall correct the intestinal derangements. Chlorate of potash, possibly combined with dilute hydrochloric acid, is exceedingly useful, both locally and internally. In the more severe cases antiseptic mouth-washes should be employed, such as the liquor sodæ chlorinatæ (1 ounce to 1 pint of water), sanitas (1 in 10), boro-glyceride (1 in 20), etc.

2. **Aphthous Stomatitis** occurs in badly-fed children, in the form of small whitish spots on a hyperæmic base, which run together, and produce ulceration. Attention to the general condition, and the local application of a little borax and honey, or a solution of boro-glyceride (1 in 20) is all that is needed.

3. **Thrush** is a very similar condition, but due to the presence of a parasitic fungus, the *Oidium albicans*. It occurs in patches somewhat resembling curdled milk in appearance, and requires the same treatment. In both these types there is often considerable

enlargement of the lymphatic glands, which, however, frequently subside without suppuration on removal of the cause.

4. **Gangrenous Stomatitis** (or **Cancrum Oris**) is much the same in origin as the preceding, but more acute in its course, both from the virulence of the organisms causing it, and from the asthenic condition of the patient. For description and treatment see p. 79.

5. **Mercurial Stomatitis** may arise during the administration of a course of mercury, or occasionally from a single dose, in persons who are extremely sensitive to the action of the drug. It is increased in its severity if the mouth and teeth are kept in a dirty state, or if the patient smokes to excess. The gums are swollen and tender, bleed on pressure, and are very painful, especially when biting, or drinking hot fluids. If the drug is continued, the teeth become loose and may fall out, whilst the alveoli may be exposed and necrose. The tongue is sometimes swollen and inflamed; salivation is also a marked symptom, and the breath becomes very offensive. *Treatment.*—Either leave off the mercury, or at any rate reduce the dose considerably, and administer saline purgatives. Chlorate of potash, combined with alum, dilute hydrochloric acid, or tincture of myrrh, may be useful locally.

6. For **Syphilitic Stomatitis**, see Chapter XXXVIII.

The buccal mucous membrane is also involved in the course of other diseases, *e.g.*, diphtheria, scarlet fever, and erysipelas, but special descriptions are not needed here.

Affections of the Tongue.

Congenital Abnormalities of the tongue are met with in the following forms: (*a*) The tongue is occasionally entirely absent. (*b*) *Tongue-tie* is said to be present when the frænum is shorter than usual, causing the tip to be depressed and fixed in the floor of the mouth so that it cannot be protruded. Sucking becomes difficult in such cases, and when it is allowed to persist, there is often a lisp in the speech. Treatment is only needed in the severer forms, and consists in raising the tongue with the index and second fingers placed one on either side, and snipping the frænum, thus put on the stretch, across its centre with a pair of blunt-pointed scissors. (*c*) The tongue may be adherent to the floor of the mouth, being *bound down* by folds of mucous membrane (*Ankyloglossia*). This may also exist as an acquired condition due to cicatricial contraction after ulceration. In congenital cases the adhesions are but slight, and the organ can be readily freed; in the acquired condition this cannot always be accomplished. (*d*) The frænum and tongue are occasionally too long, allowing of increased mobility, and even fatal results have occurred from the organ rolling backwards and impeding respiration. (*e*) The tongue may be *cleft*, presenting a bifid appearance; this may be complete or partial, and is usually associated with a congenital fissure through the lower lip and mandible. (*f*) *Macroglossia* (or large tongue), although sometimes acquired, is usually a congenital deformity. The organ is enlarged in all directions, and protrudes from the mouth, so that the teeth indent it, and cause ulceration and considerable interference with the venous return. It thus becomes purplish and dry from exposure, the mucous membrane looking almost like skin, although saliva dribbles freely from beneath it. The jaws are usually deformed from the pressure, so that, even if the tongue is reduced to its normal size by treatment, it may be impossible to close the mouth. Pathologically, it is due to diffuse overgrowth of the connective tissue, secondary to lymphatic obstruction and dilatation. The *treatment* consists in excision of a V-shaped portion, suturing the raw surfaces subsequently with catgut.

Wounds of the tongue are often caused by the teeth, especially during an epileptic seizure, or in children as a result of falls with the tongue out. There is usually brisk hæmorrhage for a few moments, which soon ceases, though blood may be extravasated into its substance, and cause considerable swelling. In simple cases the wound should be examined and purified, and the mouth constantly cleansed with mild antiseptic lotions; a few points of suture may also be inserted if necessary, but the wound must not be entirely closed, or tension from sepsis may result. When smart arterial bleeding is present, the mouth must be opened, the tongue pulled forwards, and the wounded vessel sought for and tied. Failing this, the lingual may be tied in the neck, or even the external carotid.

Poisoned wounds of the tongue from the sting of a wasp or bee cause rapid swelling, which may extend backwards, leading to œdema glottidis, and possibly fatal suffocation unless relieved by opening the windpipe.

Acute Superficial Glossitis occurs as part of a general stomatitis, and needs no special notice.

Acute Parenchymatous Glossitis, or acute inflammation of the tongue, may arise from penetrating, and of necessity septic wounds, or from the bites or stings of insects, or may be associated with acute stomatitis in the course of fevers, but is most commonly due to the injudicious administration of mercury. The condition may be limited to one half of the organ, but when arising from general causes is bilateral. The tongue becomes painful, and swells up rapidly so as to fill the mouth, and even protrude beyond the teeth, the pressure of which leads to superficial ulceration. The salivary glands are enlarged and painful, and salivation is a marked feature in the case. Speech, swallowing, and even respiration are much interfered with, and there may be considerable febrile disturbance. The case, if treated with care, usually ends in resolution; but diffuse or localized suppuration may ensue, as well as the most urgent dyspnœa, arising either from œdema glottidis or from the pressure of the enlarged organ. *Treatment* consists in stopping the mercury, or removing any evident cause, and the administration of saline purgatives with chlorate of potash. Leeches may be applied beneath the angles of the jaw, but in bad cases a free incision into the dorsum should be made on either side of the median line to give exit to the effused fluids and blood. The most rapid relief to the symptoms may be thereby obtained, although the organ may remain enlarged for some time. If asphyxia is threatening, high tracheotomy or laryngotomy may be required.

Abscess of the tongue may result from the acute process described above, but is more usually of a chronic nature, and situated at the anterior part of the organ. It is usually due to the admission of micro-organisms through some superficial lesion which has quickly healed. It presents a tense swelling, fluctuation in which may be masked by the amount of inflammatory thickening which surrounds it. A free incision both settles the diagnosis, and cures the case.

Chronic Superficial Glossitis is an exceedingly interesting and important disease, which may be associated with a similar condition of the mucous membrane lining the interior of the cheeks and lips. It is most commonly due to syphilis, occurring as a tertiary phenomenon, but may arise from excessive smoking, ragged and rough teeth, or spirit-drinking, chronic dyspepsia perhaps of a gouty nature being also present in many cases. It is very liable to be followed by epithelioma, Barker stating that out of 110 cases he carefully investigated cancer occurred in 43.

For purposes of description it is useful to divide the disease into the following five stages, although it must be clearly understood that they are merely artificial, and several of them may be present in different parts of the same tongue. (i.) The papillæ become enlarged and swollen, leading to the appearance of red hyperæmic patches, which cannot be recognised for certain unless the tongue is thoroughly dried with a handkerchief, towel, or piece of clean blotting-paper, which must not be carelessly dabbed over the organ, but should be firmly pressed down upon it so as to absorb all the moisture. (ii.) Overgrowth of epithelium over the papillæ follows, and as it increases in thickness, it becomes opaque and horny, so that the red patches are replaced by white ones, leading to the appearance which has been designated *Leucoplakia*. Sometimes the papillæ become much enlarged, and stand out definitely and separately from the organ; or the whole surface may be covered with dense white patches. To these conditions the term *Ichthyosis* has been applied. (iii.) Later on the excess of epithelium is shed, leaving red smooth patches in which the papillæ are atrophied, or have entirely disappeared. If this occurs over the greater part of the organ, the ***glazed red tongue*** so characteristic of tertiary syphilis may be produced. If, however, this process only occurs in smaller areas intermixed with portions covered with white epithelium, a patchy appearance of the tongue results, wrongly termed *Psoriasis linguæ*. (iv.) At varying periods of the disease, sometimes earlier, sometimes later, the organ becomes ulcerated, ***cracked***, or ***fissured*** in a somewhat characteristic manner. A median fissure is usually seen running down the middle, and from this cracks extend transversely, dividing the surface into rectangular compartments. (v.) Still later, epithelioma may develop, and usually in connection with one of the fissures, or of the cicatrices arising therefrom. It is often somewhat slow in its progress, owing to the amount of sclerosis induced by the preceding inflammation.

All these stages of the disease are accompanied with much discomfort, the tongue being so tender that the patient cannot drink hot fluids, or take condiments or stimulants without pain. The speech, too, may be interfered with, becoming thick and indistinct. The course of the case may vary considerably, and if cancer is not produced, the affection usually settles down after a time, and causes the patient but little discomfort as long as he conforms to the restrictions as to diet, etc., which are essential.

The *treatment* of the case is usually a matter of some difficulty. All sources of irritation must be excluded from the mouth as a first precaution. Thus, smoking or chewing tobacco must be rigidly prohibited. Spirit-drinking and all acid wines which cause pain should be forbidden, dilute whisky and water being perhaps the best stimulant. The teeth must be kept well brushed night and morning, and all stumps and rough excrescences removed. All condiments, such as mustard, spices, curry, and cheese, should be excluded from the dietary, and only simple unirritating ingesta allowed. The mouth should be washed out frequently with an alkaline wash, *e.g.*, bicarbonate of soda (20 grains to 1 ounce), or borax (10 grains to 1 ounce), especially after meals, so as to exclude all risk of acid fermentation in the débris of food. Irritating local applications, such as concentrated lactic acid, or dilute chromic acid, probably aggravate the disease. A solution of perchloride of mercury (2 grains to 1 ounce) may be painted on twice daily when the organ is cracked or ulcerated, and in the latter case powdered calomel dusted on once a day may be beneficial.

General antisyphilitic remedies may be employed where necessary; the digestion must be attended to, and if ichthyosis is present arsenic may be administered.

On the appearance of definite epithelioma suitable operative measures must be instituted.

Ulceration of the tongue may arise from a variety of causes, and occurs in many different forms. Thus, *irritable* ulcers arise from rough and carious teeth. *Dyspeptic* ulcers are associated with gastric disturbances; they are usually located on the middle of the dorsum, and are often very painful. It is sufficient to touch them with lunar caustic after dealing with the cause. *Tubercular* ulcers are not common, but are practically always secondary to pulmonary phthisis, the organ being infected by the sputum. They commence in the form of a submucous abscess, which bursts and leaves a small painful sore, rarely situated on the dorsum, but chiefly at the sides or near the tip. Secondary abscesses form around and coalesce with the original ulcer. *Treatment* is chiefly called for on account of the pain and discomfort caused by them; it consists in scraping the sores thoroughly after cocaine has been applied, touching the base with pure carbolic acid, and dressing with iodoform. Applications of cocaine may also be made before meals, as a palliative measure where radical treatment is not undertaken. *Syphilitic* and *cancerous* ulcerations are described below.

Syphilitic Disease of the tongue occurs in a variety of different forms. A *primary* syphilitic sore presents a characteristic indolent and inactive surface with subjacent infiltration, and is associated with much chronic enlargement of the submental lymphatic glands, which, however, do not tend to suppurate. In the *secondary* stages mucous tubercles, fissures, and ulcers, may form, and usually on the sides or near the tip. Occasionally one meets with a broad wart-like condyloma on the dorsum, which may be associated with longitudinal fissures; it is sometimes termed 'Hutchinson's wart.' In the *tertiary* period chronic superficial glossitis, described above, may develop, as also diffuse infiltration of the organ or gummata.

Gumma of the tongue is not uncommon, occurring usually in patients under forty years of age, as a late tertiary phenomenon. It starts as a localized submucous or intramuscular infiltration near the median line, and generally towards the middle or posterior part. The swelling is at first hard and firm, but later on becomes soft and fluctuating, and in time the overlying mucous membrane, which was unaffected, yields, and gives exit to the characteristic contents. The ulcer thus produced is oval or round in shape, and deeply excavated, the base perhaps presenting a 'wet washleather' looking slough. There is but little induration either of the base or edges, and one of the most characteristic features is the fact that neither the floor of the mouth nor base of the tongue is involved, so that the organ can be freely protruded, whilst deglutition and articulation are scarcely interfered with. The patient complains of little pain, and the submaxillary glands are only affected either as part of a general enlargement throughout the body, or from the local irritation. The progress is slow, and the effect of antisyphilitic treatment very decided, the ulcer healing readily, but leaving a localized area of sclerosis or a deep cicatrix, from which later on malignant disease may originate.

The *treatment* merely consists in the administration of iodide of potassium with or without mercury, whilst the mouth is kept clean with a simple mouth-wash.

Innocent Tumours are not commonly met with in the tongue, papillomata, cysts, and nævi being the chief varieties, and only requiring the usual treatment.

Dermoid Cysts also form within or under the tongue, originating usually in connection with the thyro-glossal duct (p. 749).

Cancer of the Tongue occurs as a squamous epithelioma, and is both a frequent and a very fatal variety of this disease. It is usually met with in men, and may arise as a result of the irritation caused by excessive smoking, especially of cigars, cigarettes, or foul pipes.

Its mode of onset varies somewhat according to the situation: (*a*) It arises most commonly as an ulcer at the margin of the organ, towards the junction of the middle and posterior thirds, and is then probably due to the irritation caused by ragged and irregular bicuspid or molar teeth; (*b*) it may start in a crack, fissure, or cicatrix on the dorsum, as a result of chronic superficial glossitis, or of a preceding gumma; (*c*) it may commence as a wart-like growth, the base of which becomes infiltrated, the tumour invading the muscular substance, and spreading to the root of the tongue; (*d*) it may originate as a submucous infiltration, starting as an ingrowth from the mucous membrane, without much external manifestation of its presence; (*e*) it may first be noticed as an irregular ulcer in the floor of the mouth; or (*f*) it may spread into the tongue from surrounding parts, such as the tonsils.

In whatever way it commences, the same features are soon manifested, viz., a new growth is noticed, hard in consistence, indefinite in its extent, which may or may not be painful from the first, and which ulcerates superficially, exposing a more or less crateriform cavity, with a gray, sloughy, foul surface, readily bleeding when touched, and discharging a foul secretion, which causes extreme fœtor of the breath. The ulcer is surrounded by an indurated mass, which gradually shelves off into the neighbouring healthy structures, or may be abruptly limited. Profuse salivation is produced by the irritation of the branches of the third division of the trigeminal, and all the movements of the tongue are painful and limited on account of the infiltration of the base, so that both swallowing and speech are difficult, the patient allowing the saliva to dribble out of his mouth. The pain is often very excessive, and usually extends along many of the branches of the fifth nerve, especially to the ear, so that sleep becomes impossible, and the patient's condition steadily and rapidly deteriorates. The glands under the chin and at the angle of the jaw early become involved in the disease, which ultimately attacks the glandulæ concatenatæ. These secondary growths are very frequently cystic in character, from the degeneration of the masses of epithelium formed within them; after a time they approach the surface and burst, leaving ragged malignant ulcers in the neck. The lower jaw, moreover, is often invaded in the later stages of the disease.

The occurrence of the typical cachexia is determined not only by the pain and consequent sleeplessness, but also by the inability to take sufficient nourishment, the absorption of products of putrefaction with the saliva swallowed, the excessive salivation, the occasional hæmorrhages, and the extent of the secondary growths. The patient rarely lasts, apart from treatment, for more than twelve months after the disease has been first noticed.

Diagnosis.—When a case is met with where the ulcer is situated at the side or base of the tongue in a patient over forty-five years of age, with the typical enlargement of the glands, profuse salivation, and impaired movements, there can be little doubt as to the diagnosis. But when it is seen in the early stage, as an infiltration of a syphilitic fissure or cicatrix, or as a small wart, it may be exceedingly difficult to determine whether or not malignant disease is present. The early enlargement of the glands, the amount of pain, the fixity of the organ, and the infiltration of the base of the ulcer, are important guiding marks; but in doubtful cases a small portion of the growth should be excised under cocaine, and subjected to careful microscopic examination, and thus its nature ascertained. Moreover, the administration of steadily increasing doses of iodide of potassium will generally bring about rapid improvement in a syphilitic case, but will do no good to an epithelioma, except perhaps temporarily when the two diseases co-exist.

Treatment.—The only hope of curing the patient lies in thorough and early removal of the growth, which, it must be remembered, has probably extended much further than one expects. Hence, no half-measures should be adopted, but complete operations, including also the lymphatic area, are advisable.

Ligature of the lingual artery and division of the gustatory nerve have been performed in cases where the disease had progressed too far to attempt radical treatment, with the double object of starving the growth and removing the pain; such, however, are of little value. Dusting the surface of the tumour with pyoktanin will perhaps give the most relief to the unfortunate patient.

Many operations for removal of the tongue have been suggested and practised from time to time, the majority of which have, however, fallen into disuse, and will not even be noticed here. We shall merely indicate the chief plans of treatment adopted at the present day. For practical purposes, the cases may be divided into two groups—those in which the disease is limited to one portion of the tongue, and the muscular tissue is not apparently invaded; and those in which glands or other structures are also obviously involved, or the tongue itself is widely infiltrated. In the first class of cases an intrabuccal operation will often suffice, combined with separate removal of the glands; in the second, more extensive extrabuccal procedures are required.

The **Intrabuccal Method** now adopted for *partial removal* of the organ is that known as *Whitehead's Operation.* The lingual artery should always be previously secured in the neck (p. 278), thus giving the surgeon an opportunity of removing the submaxillary gland with its associated lymphatics, which are so often affected. The mouth is then well opened with an efficient gag, and the chloroform is now administered by means of Junker's apparatus. A good assistant is necessary in order to prevent blood entering the larynx, small pieces of sponge held in a smooth-nosed, long-handled forceps being used to clear the pharynx. A coarse silk thread is passed through each half of the tongue to draw it forwards and steady it, and if portions of both sides are to be removed, a silver wire or silk thread should in addition be passed through the base not far from the epiglottis so as to command the stump. The essential feature of the operation is to carefully snip through the organ little by little by means of long-handled, straight, blunt-pointed scissors, picking up all the vessels as they are divided, and by this means the loss of blood is reduced to a minimum. The *modus operandi* for partial removal of one half is as follows: The tongue, being drawn out of the mouth by the two anterior loops of silk, is carefully divided down the middle line into two segments, which are readily freed from one another by the finger, the scissors merely dividing the mucous membrane. The base of the organ is freed by cutting through the line of attachment of the mucous membrane to the alveolus, and then along the middle line of the floor of the mouth to the tip of the tongue, so that the sublingual salivary gland can be also taken away—a most necessary step. The mucous lining of the dorsum is now divided transversely behind the growth, and the muscular structure of the organ slowly snipped through with scissors, and during the process, by the aid of the finger or a director, the vessels and nerves can be seen and recognised before their division. Removal of the diseased half with the gland is thus easily accomplished by making the incisions meet, and dividing the intervening tissues.

If the *tip* is alone involved, it can be removed by a V-shaped incision, made after fixing the tongue with a deep suture. The small ranine artery will spurt on each side, but is easily secured, and the gap closed by catgut sutures.

If the *whole tongue* is to be excised, or even when one side alone needs removal as far back as the epiglottis or hyoid bone, special precautions have to be taken in order to diminish the risk of asphyxia from falling back of the stump of the organ after the operation. Thus, a thick silver wire can be passed deeply through the epiglottis, by means of which it is drawn forwards, and the wire is then fixed to the upper lip by a strip of gauze and collodion. The objection to this plan is the patent condition of the glottis, into which septic exudations from the mouth are likely to run, probably inducing septic pneumonia. A much better method is that which has been introduced and largely adopted of late, viz., of performing a *preliminary tracheotomy* in order to allow the pharynx to be plugged. A Hahn's trachea-tube (*i.e.*, a large one surrounded with compressed sponge infiltrated with iodoform, which will expand and absolutely shut off the lower respiratory tract from the mouth) is inserted, or a Trendelenburg's air-tampon; or an ordinary tube may be employed if the pharynx is well packed with a sponge so as to prevent blood trickling downwards; the anæsthetic can then be administered through the tube. The advantages of this method of treatment are threefold: (*a*) The patient can be readily kept in a condition of complete anæsthesia without hindrance to the surgeon, so that the operation is more quickly finished, the shock is less, and the removal of the disease can be more thoroughly accomplished; (*b*) the patient runs no danger of asphyxia during the operation by blood trickling into the lungs, or by fragments of tissue or sponge getting loose in the mouth and being inhaled, whilst later on there is no risk from falling back of the root of the tongue; and (*c*) the chances of septic pneumonia are reduced to a minimum. Of course, opening the trachea is not entirely devoid of danger, and therefore this plan should not be adopted, except where extensive dissections are called for, and then may be undertaken with advantage a few days previously. At the time of operation the pharynx is firmly packed with a sponge.

Where the jaw, floor of the mouth, or glands in the neck are much implicated, or the tongue substance itself infiltrated, an **Extrabuccal Operation** is necessary; and of the many plans that have been recommended, we consider *Kocher's Operation*, or some modification of it, by far the best. The incision (Fig. 240), commencing close to the lobule of the ear, runs down along the anterior border of the sterno-mastoid to the great cornu of the hyoid bone, and thence forwards nearly to the middle line, and upwards to the symphysis. This flap of skin and subcutaneous tissue is dissected up, and stitched to the cheek out of harm's way. If part of the jaw also needs removal, the incision may have to extend through the lower lip, and the flap is then turned outwards and backwards so as to expose the bone. Enlarged glands are now sought for and removed, as well as the submaxillary salivary gland, the lingual and facial arteries being tied close to the carotid. Any diseased portion of the jaw is isolated by saw-cuts in front and behind it, and may be removed at once if desirable, or left *in situ* and taken away with the disease; but as already mentioned, it is always as well to leave a bridge of bone to maintain the continuity of the mandible, if it is free from disease. Where only half the tongue is to be removed, it is now split down the middle line with scissors, and the mucous membrane in the floor and side of the mouth divided so as to leave that side of the tongue attached merely by the muscular structures, which are snipped through with scissors, any bleeding points being secured as divided. If the whole organ is to be removed, it is unnecessary to divide it in the middle line. If the jaw is healthy, the reflection of mucous membrane is incised close to the alveolus, so that, by detaching the mylo-hyoid from the bone, a communication is made between the outside wound and the mouth, and the tongue is then drawn through this lateral opening, and removed close to the epiglottis behind, and close to the hyoid bone below, the whole floor of the mouth being in this way effectually dealt with.

The raw surface is painted with Whitehead's varnish (which practically consists of Friar's balsam, but with the rectified spirit replaced by a saturated solution of iodoform in ether), and, where tracheotomy has been performed, the mouth is plugged with aseptic gauze, a stomach-tube having previously been passed for feeding purposes, and brought out either through the mouth or wound.

The external incision is closed by a continuous suture, a large drain-tube being inserted at the lowest point for a few days. No attempt is made to keep the base of the tongue forwards, and, in fact, it is better that it should fall back so as to close the opening of the glottis, and so prevent septic saliva from entering the air-passages; it will be subsequently drawn forwards again by the process of cicatrization of the wound in the floor of the mouth. The plug of gauze may be removed in twenty-four hours, and replaced or not at the discretion of the surgeon. The mouth must be freely and frequently washed out with some unirritating antiseptic lotion, *e.g.*, sanitas (1 in 10), boroglyceride (1 in 20), boric acid (10 grains to 1 ounce), or a weak solution of Condy's fluid. As a rule, if all goes well, a smaller size of Hahn's tracheotomy-tube is inserted on the second day, an ordinary tube on the fifth or sixth, and even this is removed in seven to ten days. The patient is able to feed himself from a feeder with a long tube passed into the pharynx in five or six days. Where no tracheotomy has been performed, the greatest care and watchfulness will be required to prevent the stump of the tongue falling back and producing asphyxia; the mouth and pharynx must be constantly cleansed, to diminish as far as possible the risk of septic pneumonia.

This operation is certainly the most successful of any for extensive disease, and the immediate results are very satisfactory; but necessarily where the disease is so extensive as to call for such a severe procedure a considerable percentage of the cases will recur.

The great danger of the operation—septic pneumonia—is best combated by carefully cleansing the mouth and teeth previously with antiseptics, by a preliminary tracheotomy, and efficient plugging of the pharynx. Secondary hæmorrhage will occasionally be met with, but probably only in cases where the patient is very exhausted at the time of the operation, and where the mouth is not kept well washed out subsequently; it should be arrested by the actual cautery, or perchloride of iron, or the vessel may be tied in the neck if such has not already been undertaken. Antistreptococcic serum may also be utilized as a preliminary measure in order to prevent the occurrence of septic troubles; three or four injections of 10 c.c. each are made on the day preceding the operation, and perhaps one or two afterwards. The results obtained in this way have been most satisfactory.

Kocher's lines of incision may be modified according to circumstances, provided that the essential principles are kept in view, viz., the complete removal of the primary disease and of the infected glands, and the provision of effective drainage.

The removal of a part, or even the whole, of the tongue is not such a mutilation physiologically as one might expect at first. Deglutition is interfered with for a time, but the power is soon regained, and even articulation may be in great measure restored.

Affections of the Floor of the Mouth.

Sublingual Abscess occurs as an acute condition, arising from septic infection of the submucous tissue, or of a follicle of sublingual or of a submucous gland, such as might arise from a puncture by a fishbone. The inflammation which follows may either be localized or diffuse, but in both the case runs an acute course, resulting in the formation of a puffy swelling beneath the tongue, which, if not opened early, may lead to an extension downwards of the mischief into the submental region. The tongue becomes swollen and turgid from pressure upon the veins, whilst œdematous laryngitis may also be induced. Considerable constitutional disturbance generally accompanies this process. A median incision through the mucous membrane, and the insertion and opening of a pair of dressing forceps, is the safest and best method of treatment, the cavity being subsequently washed out and drained. The more diffuse form of sublingual abscess is usually associated with submaxillary cellulitis (p. 96).

Salivary Calculus generally arises in connection with the submaxillary or sublingual glands. For symptoms, etc., see p. 712.

Cystic Swellings are not uncommon about the floor of the mouth, and amongst them the following may be described:

(*a*) *Mucous Cysts* occur as a result of the distension of mucous glands; these form small translucent swellings, elastic and fluctuating. All that is needed is to open them, and remove the anterior wall.

(*b*) A *Ranula* is a very similar condition, but larger, containing a glairy mucoid fluid, and due to obstruction and distension of one of the sublingual ducts (or ducts of Rivini). A similar condition has been caused in rare cases by obstruction of Wharton's duct, but this has generally been found to run along the outer surface of the cyst. The tumour may be as large as a walnut or pigeon's egg, and may displace the tongue forwards. The *treatment* consists in removing a good-sized piece of the wall so that the cavity may be obliterated by a process of granulation.

(*c*) *Dermoid Cysts* are frequently met with in the floor of the mouth, occupying the middle line, and tending to project also into the neck beneath the chin. They are supposed to be due to non-obliteration of the upper end of the embyronic thyro-glossal canal (for a description of which, see p. 749). The contents are of the usual sebaceous type. Such tumours should never be dealt with from the mouth, as they extend deeply, and need to be carefully dissected out. A free opening must be made under the chin in the middle line, and, if feasible, the whole cyst removed unopened. If it gives way, the entire wall must be dealt with, or recurrence will certainly ensue.

Affections of the Salivary Glands.

Inflammation of the Parotid Gland is met with in several different forms.

1. **Epidemic Parotitis** (**Mumps**) is an acute specific disease, usually seen in children, highly infectious in character, and generally epidemic. The period of incubation is about three weeks, and the attack itself is evidenced by a slight febrile disturbance, associated with swelling of one or both parotid glands; one gland is attacked first, becoming enlarged and tender, the swelling beginning to diminish about the fourth day, when the other side is similarly affected. Mastication becomes difficult, owing to the tension of the parts. The swelling extends below and in front of the ear, and the socia parotidis can be distinctly felt lying over the masseter; the submaxillary, sublingual, and neighbouring lymphatic glands are also sometimes enlarged. Suppuration is rarely met with, but in adults metastatic inflammation of the testes, mammæ, or ovaries is not uncommon. Usually this complication is unilateral, and thus, although atrophy of the testis commonly follows orchitis, sterility is not produced. All that is needed in treatment is to keep the patient warm and quiet, and to administer salines. In the later stages friction with stimulating liniments will hasten resolution. After the acute attack, the gland may remain enlarged for some time.

2. A **Simple Parotitis** occasionally results from exposure to cold or from injury, whilst the presence of a calculus in the duct leads to a chronic sclerosing inflammation. The symptoms consist of pain and swelling, together with a certain amount of constitutional disturbance. An extremely interesting phenomenon is the parotitis which arises secondary to injuries or diseases of the abdominal or pelvic viscera. This condition is not very unusual, as is evident

by the fact that Stephen Paget has been able to collect 101 such cases. It was formerly always attributed to pyæmia; but as this disease was only mentioned in 15 of the 101 cases, some other cause which at present we are unable to define must be in existence. All the *treatment* required in these simple cases is the application of hot fomentations, perhaps medicated with belladonna.

3. **Suppurative Parotitis** is a much more serious condition. It may arise from extension of cocci, and inflammation from the mouth along Stenson's duct, or it may supervene in the course of pyæmia, or as a sequela of some of the exanthemata, *e.g.*, scarlet or typhoid fevers. If the inflammation extends from the mouth, suppuration occurs primarily within the tubules; under other circumstances, pus forms in the interstitial tissues. The gland becomes markedly enlarged, with congestion and œdema of the overlying skin, and, owing to the tension of the fascia, exceedingly painful. For the same reason, the pus cannot readily find its way to the surface, and hence is likely to burrow in various directions, such as amongst the muscles of the neck, or even upwards and inwards towards the base of the skull, or to the cavity of the mouth, finding its way over the border of the superior constrictor (the so-called 'sinus of Morgagni'). The constitutional symptoms from toxic absorption are usually very severe. Owing to the fact that large veins and arteries pass through the parotid gland, pyæmic symptoms are not unlikely to arise, and the prognosis is therefore somewhat serious.

Diagnosis.—Inflammation of the lymphatic glands lying on the outer surface of the parotid will closely simulate the above affections, but is distinguished from them by the fact that the socia parotidis is not enlarged.

Treatment.—In the early stages hot fomentations are employed, but as soon as there is any indication that pus has formed, a free incision must be made, and the pus evacuated. Every precaution should be taken to prevent mischief to the facial nerve, and Hilton's method of operating may be advantageously employed.

Inflammation of the **submaxillary** and **sublingual** glands may arise in an exactly similar way, but no special description is called for. Occasionally, however, the process extends beyond the submaxillary gland to the neighbouring tissues, giving rise to what has already been described as submaxillary cellulitis, or Ludwig's angina (p. 96).

Obstruction to the Flow of Saliva may occur as a result of various causes, such as cicatricial contraction in the neighbourhood of the entrance of the ducts into the mouth, or from the presence of a *salivary calculus*, consisting of a concretion of phosphate and carbonate of lime, and usually fusiform in shape.

The **Symptoms** arising from such obstruction consist mainly in a painful enlargement of the glands during and after meals, which, however, slowly passes away as the saliva finds its way past the block; if it persists for long, the gland becomes chronically enlarged, and its interstitial tissue increased in bulk, whilst a certain amount of peri-adenitis also follows. When a calculus is present, there may be a considerable discharge of offensive muco-pus into the mouth. Where the obstruction is complete, a cyst may form, and if this is opened, or finds its way to the exterior and bursts, a salivary fistula may result. It is probable that some varieties of ranula may be of this type. The formation of such a cyst, or of salivary calculi, is not very common in connection with the parotid gland, owing to the fact that the saliva excreted is limpid in character, whereas that arising from the submaxillary and sublingual glands is thick and mucoid.

Treatment.—In cases of simple obstruction, an attempt must be made to restore the natural exit, or to make an artificial one. If a calculus is present, it can usually be seen or felt at intervals projecting from the entrance of the duct; in such a case the duct must be incised, and the stone removed. Where, however, it is located in the gland substance, total removal of the organ may be necessary.

Tumours of the Parotid Gland are of considerable interest, not only on account of their situation, but also from the fact that they are usually composed of tissue rarely met with in other parts of the body.

(*a*) The **Simple** parotid tumour consists of a growth starting in the capsule or interstitial tissue of the superficial part of the gland; it contains nodules of cartilage mixed with fibrous and mucous tissue, whilst sometimes glandular elements similar to those met with in the parotid are interspersed through the mass. The tumour feels hard, firm, and nodular, but where there is much myxomatous tissue, areas of softening may be interspersed amongst the harder portions. The mass is situated between the jaw and the sterno-mastoid muscle, accessory processes also extending over the masseter in the region of the socia, and later on burrowing deeply between the mastoid bone and the styloid process, and beneath the ramus of the jaw (Fig. 252). In the early stages the tumour is freely moveable on the deeper parts, as is also the skin over the tumour, but subsequently the mass becomes fixed and adherent. The growth is exceedingly slow, often quite painless, and there is no tendency to invade lymphatic glands or produce cachexia. Mastication is much impaired, but otherwise the subjective symptoms are of but slight importance, owing to the fact that the growth is superficial to the gland, and to the more important vessels and nerves.

(*b*) **Malignant** tumours of the parotid occur in the form either of sarcoma or carcinoma. In the former case the malignant disease is not unfrequently grafted on to a simple tumour, the change of nature being marked by increased rapidity of growth and greater pain. The mass becomes more fixed, and signs of pressure upon the vessels and nerves contained within it may show themselves; the facial nerve is very likely to be implicated, leading to paralysis of the face. Moreover, the skin becomes hyperæmic and often adherent to the tumour, and finally ulceration and even fungation may obtain. Secondary deposits develop in the neighbouring lymphatic glands or in the viscera, and the patient soon passes into a state of malignant cachexia. Carcinomatous tumours are less common, but run a similar course, and, in fact, the diagnosis from sarcoma is often made only by the use of a microscope. The growth is an adenoid cancer, not unfrequently of the soft or encephaloid type, and neighbouring lymphatic glands are early enlarged and invaded.

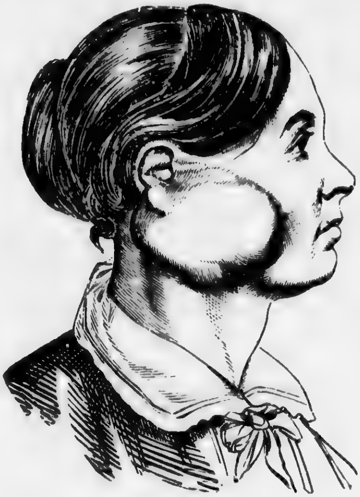


FIG. 252.—PAROTID TUMOUR. (FERGUSSON.)

The **Diagnosis** of simple parotid tumours from malignant growths is a matter of the greatest importance from a prognostic point of view, since simple tumours are, as a rule, distinctly encapsuled, and their removal, except in extreme cases, is not a matter of special difficulty; whilst malignant disease is much more diffuse, rendering complete extirpation of the mass almost impracticable. The distinction between the two forms is made by a consideration of the signs and symptoms considered above, attention being directed to the rate of growth, the condition of the skin and the surrounding parts, the mobility or not of the neoplasm, and the general aspect of the patient, whilst associated paralysis of the facial nerve is almost always characteristic of malignancy. The lymphatic glands lying on the surface of the parotid, when invaded by epithelioma secondary to some intrabuccal growth, may closely simulate a parotid tumour; it is recognised by the existence of the primary growth, and by its superficial position.

The **Treatment** of parotid tumours is often a matter of some difficulty, owing to the important character of the surrounding tissues. Removal should only be attempted if the skin is not extensively involved, if the growth is moveable on the deeper parts, and if there is no evidence of secondary deposits. Even simple tumours may occasionally become irremovable after a time on account of their deep connections and change of type. It is but rarely that malignant growths are of such a character as to justify operation, on account of their early and wide dissemination. *Simple* parotid tumours are dealt with either by making a vertical incision over the most important part of the growth, or by turning forwards a flap, exposing thereby the capsule, which is opened preferably in a transverse direction; for although the facial nerve is generally beneath the growth, it occasionally runs superficial to it, or in its substance. After this has been accomplished, the growth is often enucleated without much difficulty, but the surgeon must make certain that no deeper processes are left behind, or the growth will certainly recur. There is usually free hæmorrhage from the transverse facial and other arteries, which, however, is easily restrained. There is no need to remove redundant skin in these cases, as it readily retracts.

In dealing with early malignant disease, *excision of the whole parotid gland* may be occasionally undertaken. It is accomplished through a vertical incision, or, if the skin is involved, by two elliptical ones. The gland is then gradually freed from its connections, care being taken, if possible, to keep outside its capsule. It is best to deal with the lower part first, securing with double ligatures the external carotid artery and temporo-facial vein. The mass is then drawn upwards and forwards, and its deep connections severed. The facial nerve is, of course, divided, and the patient must be warned before the operation of the necessarily resulting facial palsy. Recurrence is almost certain to follow. Removal of the angle of the jaw as a preliminary step has been recommended, since considerable space is gained thereby, and a better access to the field of operation.

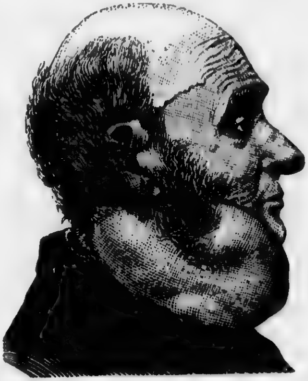


FIG. 253.—SUBMAXILLARY TUMOUR. (TILLMANNS.)

Tumours of the Submaxillary Gland are very similar in nature to those of the parotid. Simple tumours are represented by chondromata, which in this position are almost always pure and without admixture of myxoma (Fig. 253). Sarcoma and carcinoma are also met with. If seen in the early stages they are easily removed.

Salivary Fistula occurs almost solely in connection with the parotid gland. It arises from penetrating wounds of the cheek dividing Stenson's duct, or more frequently it follows operations in its neighbourhood. It is an exceedingly troublesome condition, both for the surgeon who is called upon to treat it, and for the patient who suffers from the inconvenience of saliva flowing down the cheek, the amount being, of course, increased at meal-times. Stenson's duct extends forwards from the socia parotidis across the masseter muscle for a distance of about 2 inches, and then turns abruptly inwards to pierce the buccinator, and enter the mouth opposite the second upper molar tooth. The buccal and masseteric portions are almost at right angles, the latter being represented by a line drawn from the lobule of the ear to a point midway between the ala nasi and the angle of the mouth. The diameter of the duct is about an eighth of an inch, its narrowest portion being at the orifice.

Treatment.—If the buccal portion is involved, a cure may often be attained by simply slitting up the duct within the mouth; but when the masseteric portion is wounded, and especially if near the socia parotidis, treatment becomes exceedingly difficult. We have several times found the following plan successful: A fine probe is passed along the duct from the mouth as far as the lesion; it is then grasped by forceps inserted through the external aperture, and drawn out on to the cheek, a proceeding sometimes facilitated by slightly enlarging the wound. A double thread of silk is now tied to the end of the probe, and drawn through the thickness of the cheek, along the buccal portion of the duct, and out of the external wound. To accomplish this, it may be necessary to slit up the distal portion of the duct within the mouth with a tenotome. A fine drainage-tube is now drawn through along the same track, and left so as to project both externally and internally. A silk thread is attached to each end of the tube, and these are knotted together around the angle of the mouth. By this means a passage is re-established into the mouth, and as soon as it becomes easier for the saliva to travel along this than along the external wound, the fistula will close. At the end of a few days the outer half of the tube is removed, and only a silk thread allowed to occupy the outer portion of the fistula, which gradually contracts so that more and more of the saliva finds its way into the mouth. The silk thread and tube are then finally removed, and if the opening in the mouth is kept patent, the external wound soon heals. In those cases where the buccal portion of the duct is completely obliterated or obstructed so that a probe cannot be passed, a trocar and cannula are inserted through the external wound and cheek into the mouth; a silk thread is insinuated through the cannula, and a tube drawn into position, as in the former case. The subsequent treatment is the same as that indicated above.

Affections of the Palate.

Cleft Palate.—By cleft palate is meant a congenital defect of the roof of the mouth, whereby the structures entering into its formation do not unite in the middle line, thus allowing an abnormal communication to exist between the nose and mouth. The term does not include losses of substance, resulting from injury, syphilis, or lupus. The cleft usually starts posteriorly, and extends forwards for a variable distance, although it has been known to be limited to the anterior portion of the palate and bony alveolus, but only in exceedingly rare instances. The mildest cases consist merely of a bifid uvula, perhaps not involving the palate at all; the next degree of severity affects the velum alone; more or less of the hard palate may also be implicated, the cleft reaching as far forwards as the site of the anterior palatine canal (Fig. 254); whilst the severest forms of the deformity extend in addition through the alveolus and upper lip on one or both sides, the os incisivum being in the latter case displaced forwards, perhaps on the tip of the nose.

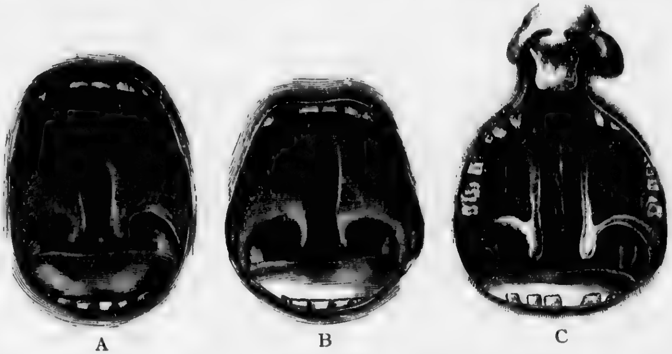


Fig. 254.—Various Forms of Cleft Palate: one Involving merely the Velum, the Second Traversing the Hard Palate as far forwards as the Anterior Palatine Canal, and the Third being Complicated with a Double Hare-lip.

On looking carefully at a cleft palate the defect usually seems to be mesial, but occasionally it appears as if a unilateral or bilateral fissure existed. To understand such an occurrence it must be remembered that there are three bony processes uniting in the middle line of the roof of the mouth, viz., the two palatine processes growing in horizontally, one on each side from the maxillæ, and the ethmo-vomerine septum growing down vertically from the under surface of the fronto-nasal process and base of the skull. All these should amicably join together about the ninth or tenth week of intra-uterine life. If, however, the palatine processes fail to reach the middle line, a median defect appears (Fig. 255, A), unless the ethmo-vomerine septum be so hypertrophied as to project between the palatal segments, when the appearance of a double cleft is produced (Fig. 255, B). When one division of the palate unites with the mesial septum, the other failing to reach it, then an apparently unilateral cleft results; most commonly the defect is on the left side, the vomer being attached to the right free edge, a left-sided alveolar harelip also complicating the case (Fig. 255, C). The reason why the anterior portion of the palate is so rarely affected without the posterior part being also involved is that the union of the various segments progresses from before backwards.

The *width* of the cleft and the slope of the segments varies greatly in different cases. The wider the cleft, the more unfavourable it is for treatment by operative means; and this is one of the arguments used in favour of the removal of the intermaxilla in cases of double harelip, so as to allow of the approximation of the two maxillæ. Remove it, they fall naturally together; leave it, and they are wedged permanently apart. As to the *slope* of the segments, the more vertical they are, the more favourable for operation, since, when flaps of muco-periosteum are loosened, they easily meet in the middle line. When they are more horizontal, and the palate like a Norman rather than a Gothic arch, the flaps are shorter, and greater lateral displacement is necessary to bring their edges into apposition, and this involves much more traction on the stitches, and hence less satisfactory results.

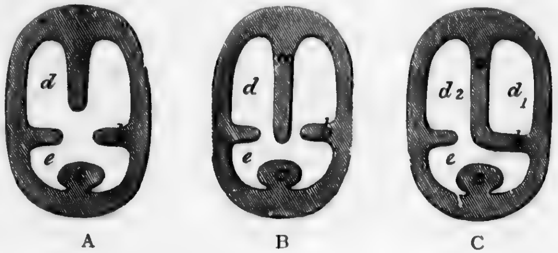


FIG. 255.—DIAGRAM TO SHOW THE MODIFICATIONS OF CLEFT PALATE.

a, Ethmo-vomerine septum; *b*, palatal segments; *c*, tongue; *d*, cavity of the nose; *e*, buccal cavity

The *effect* of such a deformity upon the infant, from a physiological point of view, is very serious. The process of *nutrition* is considerably impaired, owing to the fact that the power of suction is lost, and fluids taken into the mouth are apt to escape through the nostrils instead of being swallowed. Consequently these children must be carefully spoon-fed, otherwise they become emaciated and succumb to inanition or intercurrent maladies. If they grow up, *articulation* becomes so indistinct that it is often impossible to understand what they say, the voice having a peculiar and characteristic intonation. All the letters known as explosives, whether dentals, labials, or gutturals, requiring a certain amount of air-pressure within the mouth for their due pronunciation, are difficult to produce, particularly *b*, *d*, *p*, *t*, *g*, *f*, etc. Moreover, the exposure of the nasal mucous membrane to the air is so much greater than usual that it is exceedingly liable to catarrhal inflammation, resulting in the occurrence of exudation and scabbing, which, undergoing putrefactive changes, leads to a sort of ozæna. Both taste and smell are much diminished, partly from the unhealthy state of the mucous membrane, and also from the absence of an opposing surface against which the food can be triturated by the tongue. The *moral* effect of this deformity, particularly when associated with hare-lip, is such as to cause such patients to shun publicity from a nervous feeling of self-consciousness.

As to the best *period* at which to interfere by operation, considerable divergence of opinion exists. There are some surgeons who advocate its performance at as early a date as possible, and, in fact, it has been undertaken when the child was but a few days old. The success attending such practice has not been gratifying, since infants have no moral control, and are much more likely to suck at the stitches and interfere with them by the tongue, whilst the buccal cavity is small, and the tissues so delicate and friable, that the difficulty of the operation is much increased. On the other hand, it should not be deferred too long, for although the immediate results obtained will be much better, yet bad habits of articulation will have been contracted, and subsequent physiological success, as gauged by the quality of the speech, is much less likely to follow. After an extended experience, it may be stated that the operation may best be undertaken between the second and the third years, an age at which the child can more easily be kept under control. It is most important that the general health be good, and the mouth and throat free from local disease or inflammation. To guard against accidents it is well to make a routine practice of keeping a child under observation indoors for a few days before operating, whilst for choice the spring or summer should be chosen. If the tonsils are slightly enlarged, as is not uncommonly the case, it is by no means necessary to remove them if no active inflammation is present; pharyngeal adenoids, moreover, may sometimes be left with advantage, as they subsequently assist in shutting off the nasal cavity during speech.

Operation.—The child should be placed on a suitable table, if possible one with a moveable headpiece, as it is often necessary to alter the position of the head during the proceedings. The arms should be fixed to the sides by attaching them to a strap or bandage passed round the thighs below the trochanters, but the patient should not be tied down to the table, so that, although he cannot raise the hands to the mouth during the partial anæsthesia which is often present, yet he can be turned easily to one or the other side so as to allow blood to run from the mouth. Anæsthesia may be induced in the ordinary way by chloroform dropped upon the corner of a towel. The greatest care must be taken not to drop chloroform into the mouth, and for the same reason Junker's apparatus is undesirable, on account of the chloroform vapour irritating the edges of the cleft. The mouth is efficiently gagged open, and preferably by means of a unilateral instrument, which can easily be slipped in or out of position.

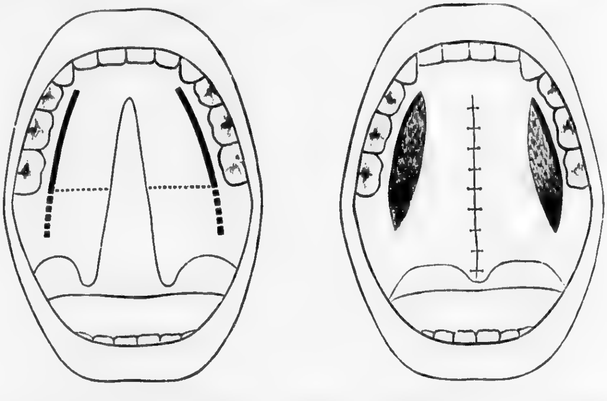


FIG. 256.—DIAGRAM TO INDICATE EXTENT OF INCISIONS IN URANOPLASTY.

The thick black lines show the primary incision; the thick dotted lines the extension backwards of the same to relieve any lateral tension; the thin dotted lines indicate approximately the position of the free border of the bony palate. The right-hand figure shows the position of the sutures, and the condition of the parts at the close of the operation.

In a case involving both the soft and hard palate there is no reason why the whole cleft should not be dealt with at one sitting. When the inter-maxillary bone has been previously removed, and a considerable gap left anteriorly, it is sometimes only possible to deal with the posterior two-thirds of the cleft, either dealing with the anterior portion at a later date, or trusting to the application of a suitable obturator, to which artificial incisors can also be attached. The proceeding now employed is practically identical with that introduced by Langenbeck, and is known as *uranoplasty*. For convenience it may be described in four stages:

Stage I.: Incision and Detachment of Muco-periosteal Flaps.—The knife should be inserted close to the last molar tooth and about half an inch from the alveolar margin, and carried forwards parallel to the teeth to a spot just anterior to the apex of the cleft; or if the alveolus is involved the incision should stop behind the lateral incisor to preserve the vascular supply of the front of the flap (Fig. 256). The muco-periosteum is thus divided down to the bone. A suitable raspatory is now introduced into the wound, and the soft structures of the palate stripped up towards the middle line, until the point of the instrument is seen protruding into the cleft. Great care is needed in dealing with the hinder part to ensure its total detachment from the hamular process and back of the bony palate, and yet not to damage it at this its weakest spot. This must be thoroughly carried out on either side, the extent of the incisions being shown by the continuous black lines in Fig. 256. Copious bleeding always accompanies this stage of the operation, and the head should be turned on one side and lowered, and the pharynx constantly sponged so as to prevent the blood passing into the air-passages.

Stage II.: Paring the Edges of the Cleft.—This is accomplished by grasping the base of the uvula with a suitable pair of angular catch-forceps. Thus steadied and held, a thin paring can be removed, in one piece, if possible, on the side seized, and the same process repeated on the other. The paring of the edges is purposely deferred until after the muco-periosteal flaps have been detached, because the freshened edges do not thus get bruised by the frequent use of the sponge; moreover, the bevel at which the edges should be pared can be more accurately estimated when the flaps have been loosened.

Stage III.: Passage and Tightening of Sutures.—The simplest plan to adopt is that known as the 'loop method' of Sir W. Fergusson, and it is carried out as follows: A long-handled palate needle with a suitable curve, and threaded with about 18 inches of fine white silk, is passed through the muco-periosteal flap from below upwards, and at a spot about 2 or 3 mm. from the margin; as a rule, it is not necessary to hold the flap to effect this. The loop of silk projecting into the cleft is now grasped with smooth-nosed forceps and drawn out of the mouth, whilst the needle is withdrawn. A similar loop is inserted through the opposite side of the cleft at an exactly corresponding point, so that there are now two loops emerging from behind through the cleft. One of these is loosely threaded through the other, and the latter gently withdrawn, carrying with it the loop-end of the former, and thus a double thread is carried through both sides of the palate, a loop projecting from one side, and the two ends from the other. This process is commenced anteriorly and carried backwards until the base of the uvula is reached, the stitches being inserted about half a centimetre apart, so that nine or ten threads may be needed to secure the whole palate. They are left loose, the ends being held by the anæsthetist against the cheeks until all have been inserted. A 6-inch length of fine well-annealed silver wire is successively hooked over each loop, drawn into position by the silk thread, and tightened to a suitable degree by a wire-twister, so that the pared edges of the cleft are exactly apposed. This is best undertaken from before backwards. Finally the uvula is stitched with silk inserted by means of a double-curved needle; silver wire would irritate the back of the tongue too much and cause vomiting.

Some surgeons, however, prefer to pass the wire by means of a specially constructed hollow needle with a double curve, through which the wire is protruded by unwinding a drum in the handle. This is passed through both flaps of the palate, commencing at the uvula, and working forwards, tying each stitch as it is inserted.

Stage IV.—It is now only necessary to take steps for the *relief of all lateral tension*, a most important and essential proceeding. The best way to accomplish this is to prolong backwards through the soft palate the lateral incisions already made so as to thoroughly divide the levator palati (see the thick dotted lines in Fig. 256). Occasionally the anterior and posterior pillars of the fauces, containing respectively the palato-glossi and palato-pharyngei muscles, will also need to be snipped across.

The child should now be put to bed with the head low, so that any accumulation of blood or mucus may gravitate easily into the pharynx. The mouth can be washed out with a weak solution of sanitas, although some surgeons prefer not to disturb the parts for three or four days. No nourishment should be given for the first four or five hours, and but very sparingly for the first twenty-four. Milk and water, given by a spoon or from a feeder, will form the staple article of diet. By about the fifth day soft food, such as soaked bread and custard pudding, may be safely taken. The patients are generally allowed up on the sixth day. The silver stitches may be left in for ten days or a fortnight without doing any harm.

In dealing with clefts of the soft palate alone, a modification of the above operation may be performed, called *staphylorraphy*. The edges are first pared, lateral incisions are then made to divide the levatores palati, and the stitches finally passed and tied.

Results.—In every case it is possible that articulation will be, if anything, impaired as the immediate result of the operation, since the mechanism which the patient ordinarily employs is thrown out of gear; subsequent education at the hands of a voice-trainer is absolutely essential in order to correct this. Even then occasionally the unpleasant articulation may persist, owing to the patient being unable to draw up the velum so as to close the posterior nares; this is due to the reduction of the depth of the soft palate from the traction required to close the cleft. In spite of this, however, the operation is most beneficial in that it shuts off the nose from the mouth, prevents the dropping of mucus, improves the sense of taste, and adds greatly to the general comfort of the patient.

Mechanical Treatment of clefts in the palate by means of obturators or artificial vela is still advocated by some surgeons and dentists in preference to any operative interference. An *obturator* consists of an adjustable plate or plug fitted to and closing an aperture in the hard palate. It may be used with advantage in perforations due to traumatism or syphilis, and in apertures left after operations in which portions of the palate are removed, such as excision of the superior maxilla. In cases of double hare-lip and cleft palate, where the os incisivum has been extirpated, an aperture is often left anteriorly which cannot be satisfactorily closed except by an obturator, which also serves to carry the necessary artificial incisors, and may have cheek plates attached to push forwards the upper lip. For whatever purpose an obturator is needed, it should never take the form of a plug, which, by its constant presence and irritation, causes the aperture to become enlarged, but always that of a plate, either of thin vulcanite or gold, which can be fixed to the teeth, and maintained in position by suction. An *artificial velum* consists of a plate obturator, to which is attached posteriorly a moveable segment to take the place of the normal velum. Such consists either of a hinged metal plate, resting on the nasal side of the segments of the soft palate, and moved by them, or of a thin indiarubber bag filled with air, sewn on to the back of the obturator. They are very complicated and difficult to keep in order, and, to our minds, the results of operative interference are infinitely superior.

Ulceration of the Palate may occur in a variety of forms, *e.g.*, (*a*) *simple*, as an accompaniment of general stomatitis: (*b*) *syphilitic*, which may involve either the hard or soft palate; if superficial, it is usually a late secondary phenomenon; if deep, it involves the bones, and often leads to necrosis, and is then due to tertiary mischief: (*c*) *lupoid*, a somewhat uncommon condition, which may result in great destruction of tissue; it is usually seen in children, and often associated with a similar disease of the nose, from which, indeed, it may have spread: (*d*) *tubercular*, due to the breaking down of a tubercular abscess under the periosteum, and then complicated with caries of the bony palate: (*e*) *malignant*, usually resulting from the growth of epithelioma, either starting primarily in the palatal mucous membrane, or extending to it from the tongue, tonsil, or upper jaw.

Acquired Perforations of the Palate, though occasionally caused by traumatism or lupus, are in almost all cases due to tertiary syphilitic disease, which either starts in the mucous membrane and extends deeply to the bones, or may commence as a subperiosteal gumma, and lead to caries and necrosis. The ethmovomerine septum is often involved in the destructive process, giving rise to a most offensive discharge from the nose. If the soft palate is alone affected, the velum may become fixed by cicatricial adhesions to the back of the pharynx, and pharyngeal stenosis or considerable loss of substance of the velum result. A nasal intonation of the voice will always be caused by any condition which interferes with the closure of the naso-pharynx by the velum during articulation. The *treatment* of these conditions should follow the usual antisyphilitic course. Perforations are, as a rule, best remedied by the use of plate obturators. We have seen out-patients make efficient obturators out of a piece of sheet indiarubber maintained *in situ* by suction, or of two pieces stitched together in the middle, one piece passing above and the other below the opening. Occasionally when the aperture is small, the local disease soundly cured, and the general health good, an attempt may be made to close it. By means of lateral incisions, extending for some distance beyond the opening, muco-periosteal flaps are raised, and the edges pared and sutured together. The results are, however, seldom satisfactory.

Any of the ordinary forms of inflammation of bone may be met with in the hard palate. **Necrosis** is usually due to tertiary syphilis, or may accompany acute subperiosteal suppuration, extending from an alveolar abscess. In either case the surgeon must wait till the sequestrum is loose, and then it may be removed or will be set free by ulceration. **Caries** is generally due to syphilis or tubercle.

Tumours are usually found in the region of the *hard* palate. Simple *epulis* (p. 666) may extend either from the alveolus, or an identical condition may start in the middle line. An *adenoma* of the palatal glands is occasionally met with. It presents a papillated appearance, somewhat resembling epithelioma, but is distinguished from it by its slower rate of growth, and the absence of ulceration, pain, or of glandular enlargement. An operation limited to the soft parts is probably all that is necessary. *Sarcoma* may be primary, and is then often myxo-sarcomatous in type, or secondary. In the former case it simulates rather closely a diffuse alveolar abscess, but is distinguished by its slower growth, less pain, absence of inflammation, and, if need be, by the results of an exploratory puncture. *Epithelioma* also occurs, but is uncommon. *Treatment* for the two latter conditions, if limited to the palate, would consist in partial removal of the affected superior maxilla.

Elongation of the Uvula is frequently the result of a chronic relaxed throat. At first it merely lasts for a time, and by the use of astringents disappears; but later on the elongation becomes chronic, and causes great irritation of the back of the tongue and fauces, resulting in a troublesome throat-cough, and possibly even vomiting. Under such circumstances it should be removed. After well cocainizing the part, it is grasped by a pair of hook-forceps, which seize not only the mucous membrane, but also the muscular structures beneath, and a sufficient amount is then removed by snipping it across near the base with a pair of blunt-pointed scissors, leaving about a third of an inch of the organ behind.

Affections of the Tonsils.

Acute Tonsillitis may result either from cold, or from the inhalation of impure air, especially when contaminated with sewer gas. It is often seen amongst the residents in hospitals (hospital throat), and may precede an attack of acute rheumatism. Three varieties are described:

(*a*) *Acute superficial tonsillitis*, which consists of a slight superficial inflammation, the result of cold, etc., in which the tonsil participates with the pharynx and velum. There is but little swelling of the part, which, however, becomes red and painful, rendering swallowing difficult. Ordinary anti-catarrhal remedies are necessary, and a chlorate of potash gargle.

(*b*) *Acute follicular tonsillitis* is characterized by a general enlargement of the organ, which is dusky red in colour, and painful, causing obstruction to both breathing and swallowing, the tonsils, perhaps, almost meeting in the middle line. There is a good deal of yellow patchy exudation from the follicles, which may coagulate on the surface, and form a false membrane, distinguished from that of diphtheria by its want of adhesion to the subjacent tissue, being readily detached from it by a camel's-hair pencil. The temperature is high, the glands below the angle of the jaw enlarged and tender, the tongue covered with a thick whitish fur, and the bowels confined. Such a condition may herald in an attack of so-called blood-poisoning, or septicæmia. As a rule, the inflammation subsides without suppuration, or if it occurs it is only superficial.

(*c*) *Acute parenchymatous tonsillitis*, or quinsy, consists of a more diffuse inflammation, which is not limited to the organ, but also involves the soft palate and fauces. The swelling is more extensive, the pain is greater, and suppuration frequently results. Other symptoms are much the same as in the above.

The **Diagnosis** must be made from *scarlet fever* by the absence of the characteristic rash and red tongue of the latter condition, and by the redness being more dusky and less diffuse in tonsillitis. From *erysipelas of the fauces*, it is known by the redness being more concentrated, the œdema less marked and more limited, by the glands at the angle of the jaw being less enlarged, and by the absence of any external manifestation of the disease.

Treatment must always be commenced by a good calomel purge, which may be followed by the administration either of salicylate of soda (20 grains, thrice daily) or of chlorate of potash and sulphate of magnesia, to which a few drops of tincture of aconite may be added if the constitutional symptoms are severe. The throat should be steamed by inhaling over boiling water, in which a little creasote or carbolic acid is dissolved, or the tonsils may be scarified. Suppuration is dealt with by a free incision, the knife entering the most prominent part of the swelling, and cutting backwards towards the middle line; the close proximity of the carotid should not however be forgotten. Hot flannels or fomentations may be applied to the neck and throat, and plenty of fluid nourishment administered. This is followed as soon as possible by iron, bark, and other tonics.

Chronic Tonsillitis occurs in two distinct forms:

(*a*) *Chronic inflammatory tonsillitis* occurs in children who, having had one acute attack, remain with the organs enlarged, painful, and congested, and are very liable to recurrence, which often runs on to suppuration and ulceration. After a time the tonsils shrink back and atrophy, becoming hard and fibroid.

(*b*) *Chronic hypertrophic tonsillitis* is met with in tubercular children, resulting from an overgrowth of the lymphoid tissue, and is usually associated with the presence of adenoids in the naso-pharynx. The tonsils are enlarged, pale in colour, and firm in consistence; the orifices of the crypts are very patent, and in them are often seen plugs of mucous secretion, which may become infiltrated with lime salts, forming concretions, which, however, are never of any great size. The patients are very liable to recurrent attacks of inflammation, with or without suppuration, and even cysts may form from the blocking of the follicular ducts. When much enlarged the tonsils may meet in the middle line beneath the uvula, causing obstruction both to swallowing and respiration. The patient usually breathes with the mouth open, owing to the concurrent naso-pharyngeal obstruction, and from the same cause speaks thickly as if he had some loose body in the mouth, and necessarily snores during sleep. Hearing is also interfered with from the mucous lining of the Eustachian tube becoming thickened and inflamed.

The **Treatment** of these cases consists in first attending to constitutional weakness by removal of the patient to fresh or seaside air, and by the administration of iron and cod-liver oil; at the same time the throat should be painted twice a day with glycerine of tannic acid, or equal parts of glycerine and tinct. ferri perchloridi, or touched with the galvano-cautery. Failing this, tonsillotomy should be performed; in children the organ may be cut away as far back as possible, but in adults, especially in trained singers, only a thin slice should be removed, and never the whole organ, for fear of damaging the voice; the stump will usually shrivel up after such treatment.

Tonsillotomy may be undertaken in two ways:

(*a*) *By the guillotine.* The fauces having been carefully and repeatedly brushed with a 5 per cent. solution of cocaine, the mouth is opened and one of the many forms of tonsil guillotine introduced; Mackenzie's spade guillotine is as good as any. The ring of the instrument is passed over the projecting organ, external pressure behind the angle of the jaw assisting in this manœuvre. By the pressure of the thumb the projecting mass is cut off by the sharp blade. In dealing with the right side, unless the surgeon is ambidextrous, he had better stand behind the patient's head, looking over into the mouth.

(*b*) *By the bistoury.* The tonsil is seized at its lowest point and drawn well inwards by means of hooked forceps, and the projecting mass removed by a straight blunt-pointed bistoury, the base of the blade being guarded, if preferred, by a piece of plaster wrapped round it. The incision should be made from below upwards, and the edge of the knife kept rather in than out, so as to avoid all risk of wounding the internal carotid, which is in close contiguity to the outer surface of the gland. The surgeon must stand behind the patient's head in dealing with the right side, and in front when operating upon the left. Care must be taken to include the lowest portion of the tonsil, which often hangs down into the pharynx, and is very frequently left behind when a guillotine is employed.

The hæmorrhage, though brisk for the moment, soon ceases if care is taken not to cut too deeply, or encroach upon the surrounding mucous membrane. Should the bleeding continue, it can generally be arrested by the use of ice or the application of wool pledgets soaked in tinct. ferri perchloridi; possibly a gargle containing hazeline may be efficacious in bad cases, or the galvano-cautery may be applied. This is more likely to occur in adults than in children.

Syphilitic Disease of the Tonsil may be met with in various stages. The *primary chancre* may be seen occasionally, in one case we know of arising from infection through a stick of caustic which had been previously used to cauterize a syphilitic ulcer and insufficiently cleaned before being applied to a tonsil, the surface of which was abraded. The glandular enlargement in the neck is very marked in such cases and the course of the disease usually severe. *Secondary ulcers* of the 'snail-track' type (*plaques muqueuses*) are common in this region, being usually symmetrical. In the tertiary period a *diffuse gummatous infiltration* occurs, involving also the palate and fauces (p. 730), and leading to pharyngeal stenosis.

Tumours of the Tonsil are almost always malignant in type, but are not very common. *Epithelioma* occurs as a firm indurated infiltration rapidly spreading to adjacent parts, and involving the lymphatic glands. It generally starts either in the root of the tongue or in the pillars of the fauces, and presents a ragged ulcerated surface with a hard margin and sloughing base. It runs a rapidly fatal course if left to itself. *Lympho-sarcoma* of the tonsil arises in the organ itself, usually occurring after middle life; it presents a smooth, dusky red appearance, the mucous membrane being stretched over it, and feels soft and almost fluctuating. In the early stages it may be freely moveable, but ere long it infiltrates surrounding structures, and affects the neighbouring lymphatic glands. *Round-celled sarcoma* may also attack the tonsil as a primary growth, and is less limited and defined than the former. In all these varieties the growth extends into the pharynx, impeding deglutition and respiration, and ulceration with or without serious hæmorrhage may ensue, and indeed the latter complication is a frequent cause of the fatal result.

Extirpation of Malignant Tumours of the tonsil is often impracticable from the extent of the disease, and the early implication of the surrounding structures, although it has now been shown that they are more amenable to treatment than was formerly thought to be the case. The disease may be dealt with in two ways: (*a*) *From the mouth* in the case of the loosely encapsuled and freely moveable lympho-sarcomata. The capsule is divided preferably by a galvano-cautery, and the growth shelled out sometimes with the utmost ease, and with very little hæmorrhage. Recurrence in the lymphatic glands is, however, very liable to follow. (*b*) *From the neck.* The best plan is to make an incision along the anterior border of the sterno-mastoid, and carefully dissect down to the pharyngeal wall, removing all lymphatic glands which are enlarged or suspicious, and securing the external carotid. The mass is then isolated from the surrounding structures and removed. A good many cases have now been reported which were treated in this manner with complete success, even when the tongue, palate, or pharynx were invaded. It is occasionally necessary to make an incision from the angle of the mouth over the angle of the jaw to the hyoid bone, and to divide the mandible along that line; the tonsil is thus well exposed, and can be dealt with satisfactorily. The patient should always be immunized to streptococcal infection before the operation.

Affections of the Pharynx.

Acute Pharyngitis is usually associated with a similar inflammatory condition of the velum palati, nasal mucous membrane, and tonsils, and may result from exposure to cold, from absorption of sewer gas, and from general diseases of the exanthematous type, *e.g.*, scarlet fever. It is characterized by redness, pain, and swelling of the mucous membrane, which becomes covered with mucus or muco-pus. An irritable cough, with perhaps sneezing, impediment to nasal respiration, and great pain on swallowing, are produced by this condition, and if it spreads to the Eustachian tube temporary deafness may be induced. Ulceration of the velum and fauces occasionally follows.

The **Treatment** consists in attending to the general condition, especially if of exanthematous origin, and when due to catarrh, in administering antiphlogistic remedies (*e.g.*, purgatives, sudorifics, and diuretics) and soothing local applications (*e.g.*, ice to suck, chlorate of potash gargle, etc.).

Erysipelas of the Fauces and Palate has been already alluded to (p. 100).

Chronic Pharyngitis is commonly met with in clergymen and public speakers who are called upon to exert their voices for any length of time, in costers and street-hawkers who shout their wares, and in drinkers and smokers. It may commence as a chronic inflammation, or may follow an acute attack. The mucous membrane is more or less red and infiltrated, with vessels coursing over it, and there is often a good deal of muco-purulent discharge. If the buccal side of the velum palati is affected there is usually much less secretion than from the pharyngeal aspect, where a considerable amount of dark green viscid material may collect and cling to the pharyngeal wall, constituting scabs, which may decompose and cause the breath to be somewhat offensive. Two main varieties are described:

1. *Chronic Follicular Pharyngitis*, in which the lymphoid follicles scattered throughout the mucous membrane become enlarged. This is specially evident upon the soft palate, but is often greater in amount upon the upper wall and sides of the pharynx, where there is a mass of lymphoid tissue, sometimes known as the *Pharyngeal or Luschka's Tonsil* (*vide* Adenoids). The uvula may be also elongated and hypertrophic in this condition.

2. *Chronic Atrophic Pharyngitis* is usually associated with the atrophic form of rhinitis sicca, and possibly with chronic laryngitis. The mucous membrane is smooth, dry, and glazed, and the exudation tends to form adherent scabs. The throat feels dry and irritable, and the voice is often husky.

The **Treatment** of chronic pharyngitis varies with the condition and character of the affection. If of a simple type ('relaxed throat'), all sources of irritation—such as smoking, spirits, and condiments—must be avoided, the bowels and digestion attended to, and astringent sprays, gargles or applications made use of, care being taken when necessary to apply these to the naso-pharynx by passing the brush up behind the soft palate. The most useful reagents to employ are the glycerine of tannic acid, equal parts of glycerine, and tinct. ferri perchloridi, whilst chloride of ammonium inhalations are sometimes valuable, as also sprays of menthol dissolved in paroleine. When the inflammation is of the follicular type, it may be further necessary to destroy the follicles with the galvano-cautery after cocainizing the surface; enlarged and varicose vessels may be divided in the same way. In the dry form of pharyngitis, inhalations of chloride of ammonium are recommended, or chloride of ammonium lozenges; the nasal condition, however, is that which most needs treatment.

Syphilitic Affections of the Pharynx may be met with in the secondary or tertiary stages. In the former they are of a superficial character, such as mucous tubercles, snail-track ulcers, etc.; in the latter they appear in the shape of a diffuse gummatous infiltration, which is often of considerable consequence, both at the time and subsequently. It manifests itself as a diffuse nodular thickening of the mucous membrane, especially in the neighbourhood of the fauces and soft palate, which rapidly runs on to ulceration, and may impede both respiration and deglutition. The administration of mercury and iodide of potassium usually causes a rapid improvement, but the subsequent cicatrization may bind down the velum, and lead to pharyngeal stenosis of such a character as to constitute a fibro-cicatricial septum, with an opening through it perhaps only large enough to allow a small bougie to pass. For such a condition little can be done; the opening may be more or less dilated by careful division of some of the bands, and the passage of bougies; but the soft palate cannot be set free when once involved in this form of stricture, nor is any plastic operation possible.

A localized gumma may form in the submucous tissue, not unfrequently involving the posterior pharyngeal wall, and running its ordinary course with or without ulceration.

Tumours of the pharynx are rarely primary. They may extend into it, however, from surrounding parts, *e.g.*, naso-pharyngeal polypi arising from the base of the skull, or retro-pharyngeal growths from the spine.

Epithelioma may either involve the pharynx primarily, or extend into it from adjacent parts, such as the tongue or tonsil. The usual type of tumour develops with some amount of ulceration; lymphatic glands become secondarily affected, and the tumour gradually tends to invade surrounding tissues, although it is interesting to note that for some time it is limited to the mucous membrane, extending widely over it, but not involving the underlying pharyngeal muscles. Death results from hæmorrhage due to ulceration into large vessels, or from interference with swallowing or breathing, or from pressure on important nerves.

Treatment.—It is only within the last decade that any attempt has been made to deal with these cases; even now the mortality is very high, and statistics go to prove that if the operation involves removal of portions of the upper or lower jaw, a fatal issue is extremely likely to follow. The same precautions as to cleansing the teeth, immunization to streptococcal infection, etc., must be taken, as in dealing with naso-pharyngeal or buccal growths. As a general rule, an incision along the anterior border of the sterno-mastoid is the best to employ, although occasionally a second may be required, splitting the cheek down to the angle of the jaw. The external carotid is tied, and all glands removed, and then the growth is extirpated, partly from without, partly from within. It is always advisable to perform a preliminary tracheotomy, and feeding must be undertaken for some days by means of a stomach-tube.

Retro-pharyngeal Abscess is acute or chronic in its course. The *acute* form may result from infection through the mucous membrane, as by fishbones, etc.; or may arise from an inflammation of the lymphatic glands which are found in this situation in children, but which usually atrophy in adults, and derive their lymph from the interior of the nose and naso-pharynx. The *chronic* variety generally follows tubercular caries of the spine, or disease of the bones at the base of the skull. Whether acute or chronic, the abscess forms a tense elastic swelling, situated behind the posterior pharyngeal wall; in the former case it is associated with high fever, and locally much redness and inflammatory œdema, which may extend to neighbouring parts, and cause considerable dyspnœa; but in the latter, where the affection is chronic, there is less local inflammatory reaction, but signs of cervical spinal disease are present. The abscess may burst into the pharynx, or may burrow outwards on either side, being guided by the pre-vertebral fascia, and point either in front or behind the sterno-mastoid.

Treatment should never be delayed from fear of the supervention of œdema of the glottis. The abscess should be opened from the neck in all cases, as then an aseptic course can be maintained, and there is no fear that the pus will enter the air-passages. If pointing in front of the sterno-mastoid, the abscess may be opened in that situation; but otherwise an incision should be made along the posterior border of the muscle, which must be drawn forwards, and the transverse processes of the cervical vertebræ clearly defined. Possibly the abscess will be opened by the necessary manipulation of the wound; if not, the index-finger of the left hand should be placed against the abscess wall in the mouth to guard it from injury, and a pair of sinus forceps thrust into the abscess in front of the vertebræ by the right hand. A drain-tube is then inserted, and the case runs an ordinary aseptic course.

Affections of the Œsophagus.

Malformations of the œsophagus are congenital or acquired. A **Congenital** communication may exist between the œsophagus and trachea, either in the form of a small fistula, or the upper end of the œsophagus ends blindly, whilst the lower end opens into the trachea near its bifurcation. Life is impossible under such conditions, and the children die shortly after birth. Congenital stricture may also be met with near the cardiac orifice, resulting in general distension and dilatation of the œsophagus (œsophagocœle). The **Acquired** malformations consist in the development of the so-called *Diverticula* from the œsophagus. Two forms have been described by Zenker: (*a*) *Pressure Diverticula*, which are the more common, and seem to be associated with some congenital weakness of the œsophageal wall. They vary much in size, perhaps becoming as large as a child's head, and rarely come under observation before the age of thirty. They usually spring from the posterior wall, close to the junction of the pharynx and œsophagus, constituting sometimes what is known as a 'pharyngocœle'; the cavity extends downwards between the œsophagus and vertebral column. The *symptoms* are due to distension of the cavity with food which stagnates and putrifies, forming a swelling in the neck which can be emptied by pressure; the difficulty of obtaining sufficient food gradually leads to emaciation. When a bougie is used, it generally passes into the diverticulum, and hence its onward course is arrested, but by careful manipulation it may be kept on the sound wall, and so slipped past the orifice into the stomach. *Treatment*, where possible, consists in exposing the diverticulum in the neck, removing it, and stitching up the opening in the pharyngeal or œsophageal wall; but such is so rarely practicable that gastrostomy holds out the best prospect of prolonging the patient's life. (*b*) *Traction Diverticula* are much rarer; they usually occur on the anterior wall, near the bifurcation of the trachea, and are due to cicatricial traction from without, as by an inflamed bronchial gland. They are of small size, and cause no symptoms, unless a foreign body lodges in them, when ulceration and perforation may lead to suppurative mediastinitis and death. They cannot be recognised *ante mortem*.

Foreign Bodies not unfrequently lodge in the œsophagus, especially in children and lunatics. Portions of food, coins, fishbones, pins, plates of false teeth, etc., are the substances usually met with. The patient complains that something has lodged in the gullet, causing a feeling of pain and distension; whilst swallowing is painful or impossible, and respiration may be more or less hampered. Large bodies are often impacted at the entrance to the gullet, and then cause sudden death from dyspnœa; if the obstruction is not so great, and remains unrelieved, œdema of the glottis may supervene. Impaction lower down is likely to be followed by ulceration, perforation, and death, either from hæmorrhage owing to one of the large vessels being opened, or from suppurative cellulitis. In some cases, however (König states about 50 per cent.), the foreign body will spontaneously pass either into the mouth or stomach.

The **Treatment** varies much according to the nature, size, and situation of the obstructing body. If small and incapable of being detected by a sound—*e.g.*, a fishbone—it is best removed by an expanding probang (Fig. 257), being caught in the loops of thick horsehair forming part of the apparatus. If a coin or small hard substance is impacted, it may be removed by œsophageal forceps, or by a coin-catcher. If it is impossible to draw it up, it may sometimes be pushed down into the stomach. A large bolus of food may be removed by forceps from the upper part of the œsophagus, and large foreign bodies—*e.g.*, plates of teeth—may be similarly extracted, using great care not to tear the mucous membrane. Skiagraphy may be usefully employed to assist in the localization of metallic substances such as coins, as also to determine whether or not they have been dislodged, and it may even be utilized to assist in the removal.

If impacted in the upper part, *œsophagotomy* may be performed. An incision, 4 inches long, is made along the anterior border of the sterno-mastoid, preferably on the left side, because the œsophagus naturally curves that way. The platysma and deep fascia are divided, and the muscle drawn outwards; the omo-hyoid needs division, and the surgeon then carefully works his way between the carotid sheath on the outer side, and the larynx and trachea on the inner, taking special care to avoid the thyroid vessels and nerves. The projection of the foreign body will indicate the situation of the tube, and this is carefully incised, and the obstruction dealt with. The œsophageal wound may then be closed by sutures which do not include the mucous membrane, whilst the external wound is either stuffed with gauze plugs or drained. When located in the upper part of the thoracic portion of the œsophagus, the tube is opened as low as possible by cutting down on the point of a bougie passed from the mouth, and it is then often possible to extricate it.

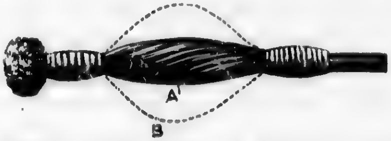


FIG. 257.—EXPANDING PROBANG FOR THE REMOVAL OF FOREIGN BODIES FROM THE ŒSOPHAGUS.

When the foreign body is impacted near the cardiac orifice, and cannot be moved either up or down, the stomach may be opened (*Gastrotomy*, p. 846), the fingers or even hand inserted into it, the cardiac orifice dilated, and the obstruction removed.

When once the foreign body has passed into the stomach, purgatives and emetics should be avoided, and if not of large size and irregular shape, the case is left to Nature, the treatment being merely expectant. The patient is kept quiet, and fed with plenty of pultaceous food—such as brown bread, porridge, etc.—and the motions are carefully examined. Should, however, the foreign body be large, and the gastric symptoms persist, it should be removed by gastrotomy.

Inflammation of the œsophagus, with or without ulceration, is caused by swallowing corrosives or irritants, and, in a more localized form, by the impaction of foreign bodies. The symptoms are pain and difficulty in deglutition, and the treatment of the former the restriction of the diet to liquids. Chronic catarrh may result from the continual drinking of raw spirits, and even stenosis from cicatricial contraction may gradually follow.

Varix of the veins in the lower portion of the œsophagus is occasionally met with as the result of pressure on the portal vein, or from cirrhosis of the liver. This is due to the fact that these branches open into the gastric division of the portal system, passing through the œsophageal opening in the diaphragm. Hæmatemesis may result therefrom, and this has even proved fatal.

Spasm of the Œsophagus, or hysterical stricture, arises in neurotic young women usually under twenty-five years of age, and, although sometimes independent of organic lesion, is often associated with some slight abrasion or ulceration of the mucous membrane, perhaps originated by the impaction at an earlier date of a fish-bone. The symptoms complained of are difficulty in swallowing, and a sensation as of a ball arising in the throat (*globus hystericus*), due to a spasmodic action of the pharyngeal constrictor muscles. At times, when the patient's attention is diverted, deglutition occurs quite normally. The best course of *treatment* to adopt is anti-neurotic in character (*e.g.*, cold douches to the spine, massage, the administration of purgatives, valerian, etc.), whilst the passage of a full-sized œsophageal bougie has been advocated.

Organic Stricture of the Œsophagus occurs in two forms—the fibrous and the malignant:

1. *Fibrous Stricture of the Œsophagus* is usually located near its commencement, just behind the cricoid cartilage, and is most frequently caused by the swallowing of corrosives, and the cicatrization of the wounds caused thereby; it also results from syphilitic disease. At the cardiac orifice it may arise from the healing and contraction of a gastric ulcer. The main *symptom* produced is a gradually increasing difficulty in the swallowing, firstly of solids, but finally even of fluids. If the obstruction is placed at the upper end of the tube, food is returned immediately; but if lower down, the œsophagus may become dilated, and in this pouch or œsophagocœle the food may collect for a time, and then be returned unchanged. There is but little pain in this form of stricture, although the patient is usually able to indicate the level of the obstruction. As the case progresses, he becomes steadily emaciated from sheer starvation, and may even die from this cause.

2. *Malignant Stricture of the Œsophagus* is usually epitheliomatous in type, occurring in subjects over forty years of age, and situated

either at the junction of the pharynx and œsophagus, *i.e.*, behind the cricoid cartilage (Fig. 258), or in the middle of the tube, where it is crossed by the left bronchus, or at the cardiac orifice of the stomach; in the latter site, columnar carcinoma is the form usually found. The growth involves the whole circumference of the tube, and sooner or later ulcerates, perhaps perforating the trachea, pleural cavity, or one of the large vessels. Secondary deposits occur in the lymphatic glands, either of the neck or posterior mediastinum, visceral complications being uncommon. The *symptoms* are similar in character to those of fibrous stenosis detailed above, but in addition the vomited materials may contain blood, and there is a good deal of pain referred usually to the site of the disease. Should the growth be at the upper end of the tube, a tumour may be distinctly felt, placed deeply in the neck and more marked on the left side; in the earlier stages nothing can be felt externally, although the side-to-side movements of the larynx may be impeded. Perforation of the trachea leads to the entrance of food into the air-passages, and rapidly results in septic pneumonia and death. When the upper part of the gullet is affected, the growth may spread to the back of the larynx, and cause hoarseness and even aphonia. Occasionally the pneumogastric nerves may be involved in the mass, leading to interference with the action of the heart.

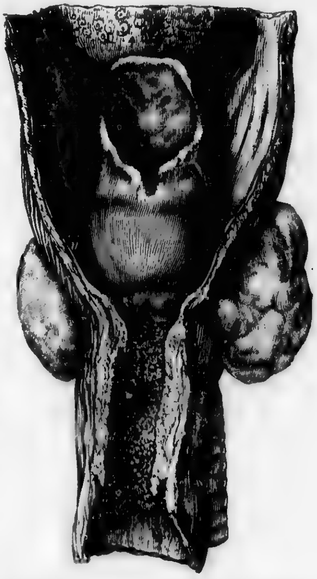


Fig. 258.—Cancerous Growth from the Œsophagus. (Treves' Surgery.)

The **Diagnosis** of œsophageal stricture must be made on general principles, and by a process of exclusion of the many other forms of dysphagia detailed below. It is confirmed by examining the condition of the tube with an œsophageal bougie. A cylindrical instrument of medium size should be employed for diagnostic purposes, and by this means the situation of the obstruction can be ascertained. *To pass an œsophageal bougie:* The surgeon stands in front and slightly to the right of the patient, who is seated with the head held forwards—if thrown backwards, the larynx is pressed against the spine, and the difficulty of introducing the instrument increased. The bougie is well warmed and smeared with glycerine, and, having been suitably curved, is guided by the surgeon's left index-finger over the epiglottis into the œsophagus. This stage usually causes a certain amount of discomfort and retching on the part of the patient. Once past the entrance to the larynx, the bougie is pushed steadily onwards until the obstruction is met with; if there is no stricture, the instrument will glide onwards into the stomach, entering that viscus at a point about 16 inches from the teeth. If any obstruction is present, the large one is withdrawn, and the passage of a smaller one attempted. The greatest care must be taken, especially in suspected malignant disease, as it is by no means difficult to perforate the walls, and open up the mediastinal tissues, even causing fatal cellulitis. As a rule, a cancerous stricture feels rough, is painful, and bleeds readily; a simple stricture is smooth and regular, almost painless, and does not bleed. It is by no means easy to distinguish the two forms, and the history of the case, and general condition of the patient, will need to be thoroughly investigated.

Treatment of Fibrous Stricture of the Œsophagus.—(*a*) Dilatation of the stricture by means of gradually increasing bougies; in some cases it may be more satisfactory to use conical-ended instruments rather than the usual type, which are of the same calibre throughout. An interval of some days should elapse between the attempts at dilatation, and during this period the patient should be given as much food as he can take in the shape of strong broths, minced meat, raw eggs, etc., or, if need be, rectal alimentation must be resorted to. (*b*) If it is impossible to dilate, or if the stricture recurs, a *Symonds' Tube* may be inserted. It consists of a gum-elastic, funnel-shaped tube, passed through the stricture by a whalebone introducer, the funnel resting against the face of the stricture. A thread attached to the upper end is brought out of the mouth in order to remove and clean it, a proceeding needed about once a fortnight (*c*) Internal œsophagotomy by means of a concealed knife has also been attempted, the stricture being divided posteriorly; it is a somewhat risky proceeding, and is only feasible when the lesion is situated high up in the tube. (*d*) When the contraction is at the pharyngeal extremity, it may be possible to open the œsophagus below, and either divide and dilate the stenosed portion, or *œsophagostomy* may be performed by sewing the mucous membrane to the skin, thus forming an entrance to the alimentary canal in the neck. Under these circumstances, it is better practice to completely divide the œsophagus, closing the upper end by sutures, and fixing the lower end to the margin of the wound. (*e*) If the cardiac orifice of the stomach is contracted, the stomach may be opened as in gastrotomy (p. 846), and the fingers used to dilate the stricture (*retrograde dilatation*), a proceeding similar to Loreta's operation for stricture of the pylorus. (*f*) Finally, where none of these proceedings are possible, or if tried have failed, the stomach must be opened, and division of the stricture by Abbe's *string saw* may be attempted. The patient is made to swallow one end of a piece of string, or a small shot may be clamped on a piece of fine silk, and allowed to find its way into the stomach. When this viscus is opened, the free end is secured, and by its means a coarse silk thread is carried through the obstruction; by up-and-down sawing movements the stricture can be thereby divided, enabling the surgeon to introduce bougies. Excellent results have been reported from such practice. (*g*) *Gastrostomy* is the final resort (p. 848); occasionally, when the œsophagus has by this means been kept at rest for some time, the stricture will yield, and dilatation by bougies becomes practicable. In such a case the opening in the stomach may be allowed to close.

Treatment of Malignant Disease of the Œsophagus follows much on the same lines. Dilatation by bougies should not be employed as a routine practice, for fear of increasing the ulceration, causing severe hæmorrhage, or perforating the walls of the tube. It may, however, be used as a temporary measure to enable the patient to take an increased amount of food, and thus for a time improve his general condition and render him more fitted to undergo further treatment. Symonds' method of *tubage* may also be utilized in malignant disease, the patients often bearing the inserted tube well, even when the cardiac orifice is involved, the lower end then projecting into the cavity of the stomach. Unfortunately these tubes occasionally slip through into the stomach, or the guiding string is swallowed; moreover, under the best circumstances the tube needs changing every fortnight, and the ulceration may be increased thereby. Hence *gastrostomy*, performed as soon as possible by one of the modern methods, is a much more satisfactory plan of treatment. Excision of the growth in the neck has been successfully accomplished in a few cases when the disease was recognised early, and very limited in extent. Tracheotomy is occasionally called for in the later stages, from implication of the glottis or trachea.

By the term **Dysphagia** is meant a condition in which swallowing is painful or difficult. The **Causes** are very numerous, and may be arranged as follows:

i. *Pharyngeal*—*e.g.*, acute or chronic inflammation, whether simple, scarlatinal, diphtheritic, etc.; ulceration of syphilitic or malignant origin; stenosis, as a result of ulceration; paralysis (*e.g.*, labio-glosso-laryngeal or bulbar); impaction of foreign bodies; naso-pharyngeal polypi projecting behind the velum; retro-pharyngeal abscess or tumour, etc.

ii. *Laryngeal*—*e.g.*, acute or chronic laryngitis; tubercular, syphilitic, or malignant disease.

iii. *Œsophageal*—*e.g.*, acute or chronic inflammation, impaction of foreign bodies, the presence of diverticula, œsophagospasm, and simple or malignant stricture.

iv. *Extrinsic*. In the *neck*: goitre, enlarged glands, aneurisms, etc.; in the *thorax*: mediastinal growths or glands, aneurisms of the aorta and large vessels, tumours growing from the vertebral bodies, pericardial effusion, and displacement backwards of the sternal end of the clavicle.

To *investigate a case of dysphagia*, note: (i.) the method of onset, whether acute or chronic—if the former, it is probably due to a foreign body; (ii.) the condition of the pharynx as seen from the mouth and on digital exploration; (iii.) the condition of the neck as seen and felt from without, whether or not a tumour is to be felt behind the cricoid, or whether a goitre or aneurism exists; (iv.) the character of the voice, as indicative or not of laryngeal mischief—if the voice is husky, a laryngoscopic examination must be made; (v.) the chest must be carefully examined for aneurisms, etc.; (vi.) the œsophagus may be auscultated along the vertebral groove whilst the patient drinks water to ascertain the situation of the mischief; (vii.) it must be examined finally by bougies. If the obstruction is in the œsophagus, the patient's age and general condition will give prima-facie evidence as to whether or not it is due to malignant disease; but it must not be forgotten that stenosis of itself will quite explain some of the loss of flesh and of weight. The presence of blood and offensive mucus on the bougie or in the material vomited, and the existence of enlarged glands in the neck, will also assist in establishing a diagnosis.

CHAPTER XXV.

AFFECTIONS OF THE EAR.

It is impossible to do more than deal with some of the more important surgical aspects of diseases of the ear in this place, and for a more detailed consideration of the subject we must refer our readers to special text-books.

The **External Ear** is the site of various affections which may come under the observation of the general surgeon. Thus, the pinna may be **congenitally absent**, and even the external meatus closed, a malformation often associated with macrostoma. Nothing can be done for this want of development, and the surgeon must never be tempted to try and dig out the concealed tympanum. More frequently, however, **accessory auricles** are present, consisting merely of fibro-cartilage covered with fat and skin. **Large and prominent ears** constitute a very unsightly deformity, for which operative interference is occasionally required. The size may be diminished by removing a V-shaped portion from the upper part; the prominence, by excising a portion of skin and cartilage through an incision on the posterior aspect. The wounds thus produced are accurately sutured together, and considerable improvement in the appearance results. **Hæmatoma** of the ear is usually due to injury, but is occasionally idiopathic in origin, especially amongst the insane. The auricle becomes swollen and enlarged and of a bluish-red colour in traumatic cases (Fig. 259); unless inflamed it should not be interfered with, as a general rule, although, if the appearance of the patient is important, it may be advisable to evacuate the blood, since its organization and subsequent contraction may lead to considerable deformity. **Eczema**, **boils**, and other inflammatory affections, are met with in the external ear and pinna, but these call for no special mention.

Plugs of wax, which become dark and indurated, not unfrequently block the meatus, leading to more or less complete deafness; this may come on suddenly after bathing, owing to the plug rapidly swelling up. If they encroach on the membrana tympani, subjective symptoms of giddiness, vomiting, and rushing noises in the ear may also be caused. On examination with an ear speculum, their presence is readily detected. *Treatment* consists in washing them away, after previously softening with oil or glycerine. A large syringe with a fine nozzle should be used, and a stream of warm water injected along the roof of the meatus; as it returns, the softened masses of wax are washed away. **Foreign bodies** in the meatus, such as buttons or beads, are similarly removed, if possible, by syringing; if this fails, a fine pair of forceps is employed for the purpose, but it must be remembered that delicate structures lie behind the foreign body, which can readily be harmed by the exhibition of impatience or force. Where all other plans fail, the auricle may be turned forwards and the meatus opened from behind. **Exostoses** are occasionally met with springing from the bony walls of the meatus; they give rise to deafness by obstructing the passage, and may be removed by the dental drill.

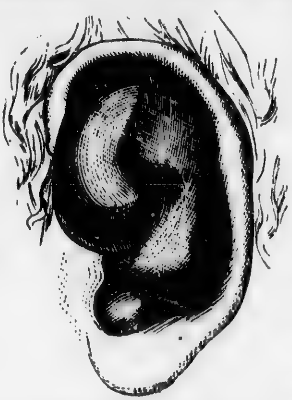


FIG. 259.—HÆMATOMA AURIS.

The **Surgical Complications of Chronic Otorrhœa** are frequently serious, and call for prompt treatment. The discharge usually comes from the middle ear (*otitis media*) through a perforation in the tympanic membrane. It must be noted that the tympanic cavity is lined by a mucous membrane which is in direct communication through the Eustachian tube with that lining the nasal fossæ; and this membrane being adherent to the periosteal lining of the cavity, every case of otitis media is likely to be associated with an internal periostitis of the temporal bone. These complications may be classified under three main headings—the extracranial, the cranial, and the intracranial.

The **extracranial complications of otorrhœa** are comparatively unimportant.

(*a*) **Eczema** of the meatus is frequently seen, and merely needs the parts to be kept dry and clean, and possibly a little boric acid powder insufflated; it readily disappears when the discharge ceases, but is not unfrequently associated with enlargement of the cervical glands, which may suppurate, or in predisposed individuals may become the seat of tubercular disease.

(*b*) **Boils** arise from infection of the sebaceous glands in the meatus with pyogenic cocci from the discharge, and are exceedingly painful owing to the denseness of the tissues involved.

They should be fomented with hot water, and opened when pus has formed.

(*c*) **Polypi** may also develop, consisting essentially of granulation tissue protruding through an opening in the membrane; they lead to considerable obstruction, and may do harm by keeping back the discharge. They should be removed by the curette, and the bare bone, usually felt at their base, scraped; the part is subsequently syringed with a weak carbolic solution and dressed antiseptically.

(*d*) Inflammation may occasionally spread from the meatus to the tympanic plate of the temporal bone, leading to subperiosteal abscess and necrosis; or it may extend along the Glaserian fissure into the temporo-maxillary articulation, giving rise to suppurative arthritis and disorganization of that joint (p. 678).

The **cranial complications of otitis media** are often of a grave nature, and may end in permanent deafness, or even endanger the life of the individual.

(*a*) The **ossicles** frequently necrose, and are cast off in the discharge, and thus hearing may be impaired, although not necessarily destroyed; ankylosis of the ossicles one to another may also be determined, leading to considerable, if not total, loss of function.

(*b*) The inflammation may extend from the lining membrane of the tympanum to the bony walls surrounding it, giving rise to a limited **caries or necrosis of the temporal bone**. This may be associated with suppuration within the skull, and any of the intracranial complications mentioned below. The roof of the tympanic cavity, which is very thin, is especially liable to be affected in this way. If diseased bone can be felt through the external auditory meatus with a probe, an attempt should be made to remove it; if this is impossible, the part must be kept clean by the injection of mild antiseptics, retention of discharges being prevented by the regular use of Politzer's bag.

(*c*) **Facial paralysis** not uncommonly arises from sclerosis and thickening of the bony tissue surrounding the aqueductus Fallopii, causing pressure on the nerve in that region. It must be remembered that the bony canal lies immediately behind the tympanic cavity, and to the inner side of the entrance to the mastoid cells. All the muscles on that side of the face are involved, and possibly also the palate and uvula. No radical treatment is practicable, although the face should be regularly faradized, so as to maintain as far as possible the tone of the muscles.

(*d*) Inflammation may also extend into the mastoid cells, giving rise to the condition known as **mastoiditis**. The mastoid process is a triangular process of bone, which is practically undeveloped until the age of puberty. Before that period a single cell which communicates with the posterior portion of the tympanic cavity represents the antrum; but after puberty not only is this cavity of some size, but the whole bone is hollowed out into a series of spongy cells, lined with mucous membrane, which open into the floor of the antrum. When the inflammatory process in otitis media, which is almost always septic, extends into this bony process, severe local and general symptoms are likely to result. The patient complains of intense pain in the ear, with tenderness on pressure, and perhaps redness and œdema over the mastoid process. The discharge from the ear often ceases for a time at the commencement of these symptoms, but reappears later on. As the case progresses, febrile symptoms of an intermittent type, and even rigors, may supervene, whilst the patient becomes drowsy, or may be irritable and restless. An abscess may form under the periosteum covering the mastoid process, with or without caries or necrosis of the outer table of the bone; in children, where this bony lamella is thin, it is not unfrequently absorbed, and on incising the abscess protuberant masses of granulation, springing from the interior of the bone, may be seen. Any of the intracranial complications mentioned below may occur as sequelæ. Occasionally the mastoid trouble is of a more chronic type, the cells being choked up with lymph and inflammatory material of a cheesy nature, whilst the bone itself becomes thickened and condensed. The process feels distinctly enlarged, and a good deal of deep-seated pain is experienced of an aching character, and worse at night.

Treatment.—In the early acute stage belladonna fomentations may be employed, and the patient kept quietly in bed, whilst the diet is regulated and a suitable purgative administered; accumulated discharge is removed from the tympanum by the use of Politzer's bag. Two or three leeches may also be applied over the mastoid process, and relief to the pain thus obtained, though it is often only of a temporary character. It is most important not to rely upon such palliative measures for too long, but when the symptoms are well marked, even in the early stages, and before suppuration has occurred, it is good practice to make an incision (*Wilde's incision*) down to the bone, reaching from the base to the apex of the process; much relief is always obtained by this procedure, and not unfrequently the inflammatory process is completely checked. Should this not succeed, the mastoid *antrum must be laid open* and its contents evacuated. Many methods have been suggested in order to accomplish this; thus, it has been recommended to use the bradawl, trephine, gouge, or gimlet; the gouge is, however, probably the best. A vertical incision is made immediately behind the ear, and the gouge applied on a level with the roof of the external auditory meatus, and about ½ inch behind its centre. A small dimple in the bone can often be felt at the required spot, which can also be found by taking the point of junction of two lines drawn as tangents to the roof and posterior wall of the bony meatus respectively (Fig. 260, C). The direction taken by the gouge should be slightly downwards, forwards, and inwards, and a useful guide will be found in a probe passed down the external auditory meatus, the boring being made exactly parallel to this. In an adult the mastoid antrum is reached about three-fifths of an inch from the surface of the bone. The surgeon recognises that he has opened the cavity by the loss of resistance, and the escape of exceedingly offensive pus. The opening is then freely enlarged by the use of the gouge and cutting pliers, and the cavity syringed out through the external meatus. Diseased bone in the mastoid process or around the tympanic cavity may be scraped away, and the wound plugged with antiseptic gauze; it should be syringed through from the external meatus daily. In the more chronic cases it may be advisable to split off the whole of the outer coating of bone from the mastoid process, so as to lay open all the cells, which will often be found filled with inspissated pus. In the more severe forms it is recommended to detach the auricle posteriorly from the bony margins of the meatus, and then to chisel away the whole of the osseous tissue intervening between the meatus and the opening into the mastoid antrum. The remains of the membrane and the ossicles are then removed, and the whole cavity well curetted (*Stacke's operation*). The results of this proceeding have been very satisfactory, but the proximity of the facial nerve must not be forgotten, for fear of inducing paralysis of the face.

The **intracranial complications** of otorrhœa are subcranial abscess, localized or diffuse meningitis, thrombosis of the lateral sinus, and abscess in the cerebrum or cerebellum.

(*a*) **Subcranial Abscess.**—When the roof of the tympanum or any part of the lining of that cavity which encroaches on the cranium becomes inflamed or carious, suppuration between the skull and dura mater may ensue. The membranes are gradually stripped from the bone by the increasing pressure of the exudation, and symptoms of cerebral compression and irritation are thereby induced. Accumulations of pus occur most commonly along the summit of the petrous portion of the temporal bone, and in the sulcus in which the lateral sinus is lodged. The patient complains of pain and headache, which continues to increase for a time, and then is followed by drowsiness, which may pass into coma. The temperature is usually raised, but rigors, even if present at first, are by no means a constant feature of the case. The pulse is of the usual febrile type, viz., full and bounding. There is no pain in the neck along the course of the jugular vein, but retraction of the head occurs if basal meningitis is present, and vomiting is a marked symptom. Optic neuritis may be observed in consequence of the inflammation extending to the membranes at the base of the brain. There may be some tenderness on pressure over the temporal region, and even possibly œdema. In some cases the pus finds its way outwards along the mastoid emissary vein, or through the suture between the occipital and temporal bones.

The **Diagnosis** from cerebral abscess is sometimes a matter of considerable difficulty. The symptoms, however, set in somewhat more acutely, whilst the temperature is raised, and the signs of irritation of the membranes, such as retraction of the neck, all suggest that the lesion is extradural, and not cerebral in origin. The pulse is fast, and not slow, and focal symptoms are less likely to develop.

The **Treatment** consists in trephining above and behind the meatus, so as to escape the lateral sinus, and in much the same situation as for a temporo-sphenoidal abscess (*q.v.*). The pus is washed out, and a drainage-tube inserted for a few days.

(*b*) **Meningitis** may be localized or diffuse. The former usually accompanies some other condition, and is in itself of little moment. It may produce fixed headache, but, if non-suppurative, usually disappears when the originating disease has been cured. The diffuse variety is generally septic in nature, and secondary to some suppurative affection in the neighbourhood, or to thrombosis of the lateral sinus. For symptoms, see p. 485. Occasionally a simple serous effusion occurs within the meninges, leading to increased pressure and consequent drowsiness, but disappearing entirely when the cause has been removed.

(*c*) **Thrombosis of the Lateral Sinus** arises from direct extension of the inflammatory process from the middle ear through the mastoid bone, or it may be set up by a septic thrombosis of the mastoid emissary vein spreading to the sinus. A clot forms within it, which, gradually increasing in size, leads finally to occlusion of its lumen. Infection with pyogenic organisms from the neighbouring disease determines disintegration of the clot, septic emboli are detached, and thus pyæmic symptoms originated. In well-marked cases the thrombus extends as far back as the Torcular Herophili, and along the jugular vein into the neck.

The most marked **Symptom** of the case is the sudden appearance of a high temperature, which is usually remittent, and associated with rigors, vomiting, and localized pain in the head, perhaps most marked over the point of emergence of the emissary vein at the posterior border of the mastoid process. The pulse is slow and easily compressible, and in the later stages the patient is drowsy and dull, probably from serous exudation within the meninges. The discharge from the ear, which may have been previously offensive, usually ceases. Optic neuritis may or may not exist, being often preceded by photophobia. If the thrombosis

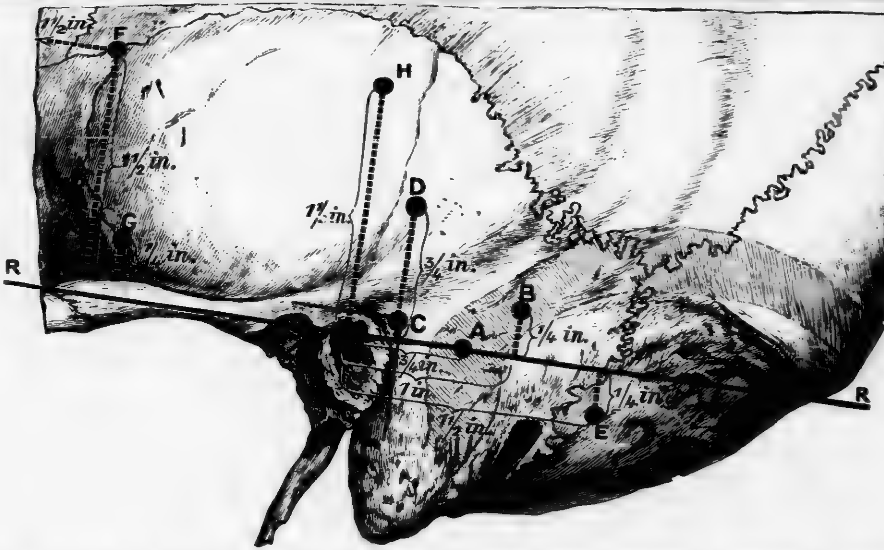
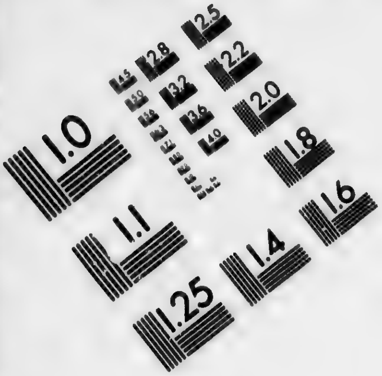
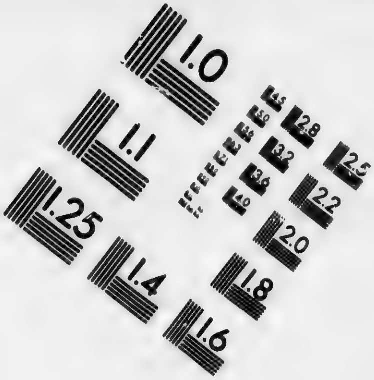


Fig. 260.—Diagram of Adult Skull (Natural Size) to show Various Spots for Trephining. (Treves' Surgery.)

The horizontal measurements are taken along Reid's base line, R, R, from the centre of the external auditory meatus; the vertical measurements are taken by drawing lines at right angles to the base line. A, The sigmoid portion of the lateral sinus, a point ¾ inch along the base line from the centre of the meatus; B, the transverse portion of the sinus, 1 inch behind the meatus, and ¼ inch above the base line; C, the mastoid antrum, the point of meeting of two lines—one drawn along the upper wall of the meatus and parallel to the base line, the other along the posterior wall of the meatus at right angles to Reid's line; D, for temporo-sphenoidal abscess, a line drawn ¾ inch upwards through the posterior border of the meatus at right angles to the base line; E, for cerebellar abscess, 1½ inches behind the centre of the meatus, and ¼ inch below the base line; F, for anterior branch of middle meningeal, 1½ inches behind external angular process of frontal bone, and 1½ inches above the zygoma; G, for posterior branch of middle meningeal, 1¾ inches behind external angular process, and ¼ inch above zygoma; H, for tapping lateral ventricle, 1½ inches above centre of external auditory meatus.





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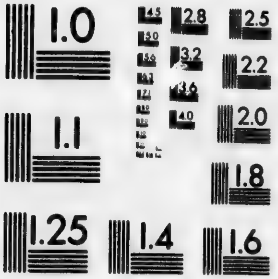

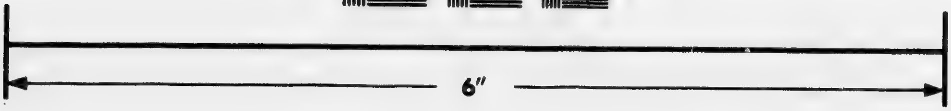

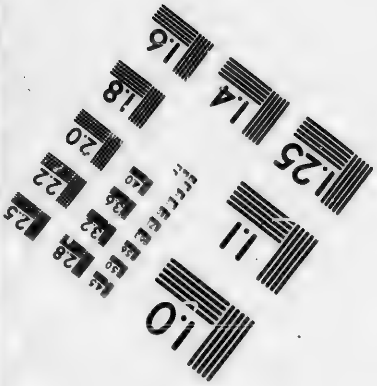

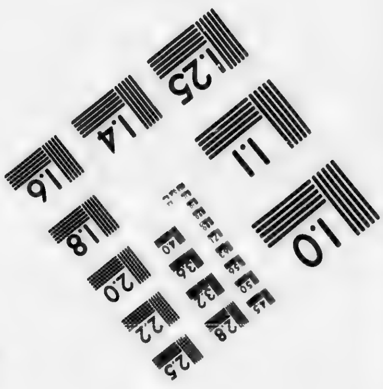

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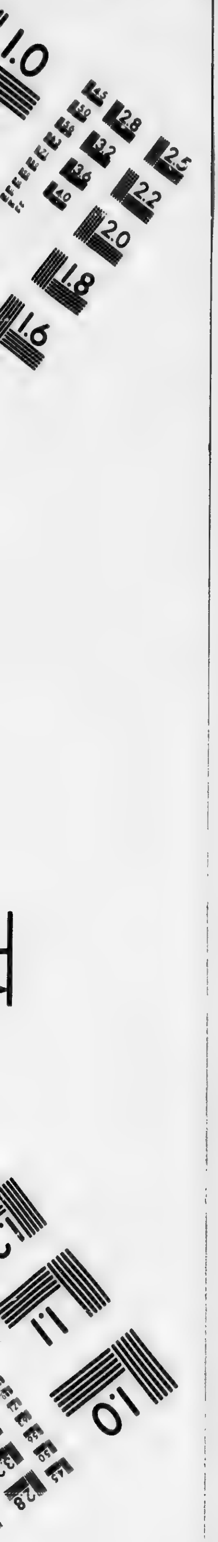
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extends into the neck, a firm, tender, elongated swelling is felt in the region of the jugular vein, and, owing to the interference with the venous circulation, the face often becomes dusky. Stiffness of the muscles at the back of the neck is an evidence of a certain amount of associated basal meningitis, as is also the optic neuritis. Suppuration may occur outside the sinus, or around the vein in the neck, which becomes swollen, red, and œdematous.

In well-marked cases the **Diagnosis** is easily made, but in the early stages, and especially in children, it is often a matter of some difficulty. The abrupt onset, the oscillating temperature, the recurrent rigors, the pain in the neck, and the deep tenderness on pressure over the course of the lateral sinus or jugular vein, are the most reliable signs of this affection.

Treatment, to be successful, should be undertaken early. The skull is trephined at a spot about ¼ inch above Reid's base line, and about 1 inch behind the centre of the external auditory meatus (Fig. 260, A or B). The outer wall of the sinus is thereby exposed, and a puncture with a fine needle readily determines whether it contains normal blood or thrombus. If it is thrombosed, there is often some evidence of inflammation or pus around it, between the dura mater and the bone. Having thus verified the diagnosis, an incision is made along the anterior border of the sterno-mastoid, through which the jugular vein is tied at a spot below the lowest point of the thrombus, so as to prevent any more emboli from passing into the general circulation. The lateral sinus is now freely opened, as also the jugular vein above the ligature, and the septic thrombus partly scraped, partly washed away, additional bone being removed if necessary. It is desirable to completely remove the lower part of the thrombus, but such is not essential. Bleeding occurs from the posterior part of the upper opening as soon as all the coagulum is removed, but it is easily controlled by plugging the lateral sinus with aseptic sponge or gauze. The wound in the neck should be only partially closed, and lightly stuffed with gauze, since septic infection is almost certain to follow. The upper wound is also packed in the same way, and allowed to granulate.

(*d*) **Abscess** in the cerebrum or cerebellum is a complication not unfrequently met with, and, indeed, 50 per cent. of all abscesses of the brain are due to this cause. The inflammation spreads from the middle ear through the bone to the meninges, and thence either directly to the cerebral substance through adhesions which have previously formed, or along veins or lymphatics. In the majority of cases (Barker states nine-tenths) the abscess is situated in the posterior part of the temporo-sphenoidal lobe. Cerebellar abscess is more common in adults than in children, occurs in the anterior portion of one of the lateral lobes, and is probably induced by disease of the mastoid.

The **General Symptoms** of cerebral abscess are considered elsewhere (p. 651). In middle-ear mischief they are usually insidious in onset and chronic in type, though they may terminate suddenly in a train of phenomena similar to apoplexy, due to rupture into the lateral ventricle, or to the occurrence of an acute spreading œdema (p. 489). The *focal effects* vary with the situation. In most cases of temporo-sphenoidal abscess they are not marked; but if the anterior part is involved, irritative or paralytic symptoms may be noted on the opposite side of the face, or aphasia if the lesion is on the left hemisphere, whilst if situated in the posterior part symptoms of incoordination and giddiness may arise from pressure on the cerebellum through the tentorium, almost exactly simulating those due to an abscess or tumour in the cerebellum.

The **Diagnosis** from thrombosis of the lateral sinus is, as a rule, not difficult, owing to the fact that in abscess symptoms of compression are associated with a low temperature and marked optic neuritis; whereas in thrombosis the temperature is high and oscillating, optic neuritis may be absent, and there may be the characteristic tenderness in the neck. It must not be forgotten that the two conditions may co-exist. The diagnosis from *subcranial abscess* has been already noted.

The **Treatment** consists in evacuation of the pus as described at p. 651. For an abscess in the temporo-sphenoidal lobe, the centre pin of the trephine should be placed 1¼ inches above Reid's base line, and about the same distance behind the centre of the external auditory meatus, although some authors recommend a spot ¾ inch above Reid's base line, and corresponding to the posterior border of the osseous meatus (Fig. 260, D). For an abscess in the cerebellum the point selected is 1½ inches behind the centre of the external auditory meatus, and ¼ inch below the base line (Fig. 260, E). In the latter case the soft parts, including the muscles and periosteum, should be stripped off the occipital bone, and turned downwards, and it is often unnecessary to apply a trephine, as the bone is very thin, and may be broken through with a gouge.

CHAPTER XXVI.

SURGERY OF THE NECK.

Affections of the Neck.

Affections connected with the Branchial Clefts.—In the second or third week of intra-uterine life a series of branchial arches form in the human embryo, as in other mammalia, which constitute the foundation from which the future structures of the neck are developed. In the majority of mammals five such post-oral arches occur, separated from one another by the so-called branchial clefts; but in man the fourth and fifth are amalgamated. They project from the side of the primitive spinal column, and consist of mesoblast lined on either side by epithelium. They unite across the median line at an early date, and also one with another, thereby leading to a large extent to the obliteration of the clefts. Occasionally, however, this union is imperfect, and sundry malformations result.

It must be remembered that the mandible and the processus gracilis of the malleus arise from the first arch; the Eustachian tube, tympanic cavity, external auditory meatus, and Glaserian fissure from a normally unobliterated portion of the first cleft; the styloid process, stylo-hyoid ligament and lesser cornu of the hyoid bone from the second arch; the body and great cornu of the hyoid bone from the third arch; and the rest of the cervical tissues from the remaining arch; whilst the second, third, and fourth clefts are, under ordinary circumstances, totally obliterated.

Branchial Fistulæ are due to imperfect closure of the branchial clefts. They consist of narrow sinuous tracts extending inwards from the skin, and perhaps communicating, but not necessarily so, with the pharynx. The external opening is usually situated along the anterior border of the sterno-mastoid muscle, and most commonly near its lower end, close to the episternal notch, thus arising from the lowest cleft. They are lined with epithelium, and secrete a glairy or mucoid fluid. They are not uncommonly associated with other abnormalities, such as macrostoma, absence of the pinna, or accessory auricles situated either near the orifice of the fistula or close to the ear. In the majority of cases they may be disregarded, but if troublesome should be laid open and the lining membrane either dissected away or destroyed with the galvano-cautery.

Branchial Cysts arise from incomplete obliteration of a branchial cleft, the unobliterated portion being distended with secretion. They usually appear in adolescents, often between the ages of ten and twenty, and are frequently attributed to a blow, which, it may be presumed, brings into activity structures which would otherwise have remained passive. They grow slowly and painlessly, forming rounded swellings with more or less distinct fluctuation, according to the depth at which they are situated; their contents, if near the cutaneous end of the cleft, may be sebaceous in character, similar to that found in dermoid cysts, but if placed nearer to the pharynx they are occupied by a glairy mucoid fluid. They are usually lined with squamous epithelium, but a few cases have been recorded in which the cells were columnar, and even ciliated, in character. The most common situation is in the third cleft, the cyst then lying between the thyroid cartilage and the anterior border of the sterno-mastoid, in relation with the great wing of the hyoid bone; when of large size they may extend beneath that muscle, displacing it outwards. More rarely a cyst arises from the second cleft, being then located in the upper third of the neck, and tending to spread up towards the styloid process; it may even reach from the mastoid process to the hyoid bone, running parallel to the posterior border of the jaw, and fluctuation may be detected through the mouth. *Treatment* consists in extirpation where possible, if the condition gives rise to any trouble.

Branchial Carcinoma.—Considerable doubt has been expressed as to whether it is possible for carcinoma to originate in the unobliterated remains of the branchial clefts, cases which might have been considered of this nature being ascribed to developments of epithelioma in the deep lymphatic glands which have undergone cystic degeneration, and secondary to some undiscovered or aborted lesion in the pharynx or larynx. The balance of evidence is, however, in favour of the fact that squamous epithelioma can start in this way, giving rise to what has been described as a *malignant cyst of the neck*. Such is characterized by the formation of a tumour placed deeply beneath the sterno-mastoid, indefinite in outline, and of firm consistence. Considerable pain is experienced, and lymphatic glands become secondarily enlarged. The disease runs its ordinary course, but may destroy life through hæmorrhage from the main vessels, which are invaded by the tumour. The cyst sometimes gives way into the pharynx, and an epitheliomatous ulcer of the pharyngeal wall is thus induced. *Treatment* is impracticable owing to the deep connections of the growth.

Various other congenital conditions may be met with in the neck. **Congenital induration of the sterno-mastoid** in all probability arises from injury during parturition, and usually occurs in head presentations, probably from bruising of the side of the neck against the under surface of the symphysis; it is said to be more common on the left side than on the right. In cases that have been examined microscopically, the indurated mass has been found to consist of fibrous tissue. It disappears spontaneously after a time, but may lead to torticollis at a later date. The congenital form of **torticollis** (p. 606), **cysts** in connection with the thyro-glossal duct, and **cystic hygroma**, may also be mentioned.

Cysts of the Neck.

Many different varieties of cysts are found in the neck, and may be described as congenital or acquired in origin.

1. **Cysts of Congenital Origin.**—(*a*) *Dermoids* occur here as in any other region where congenital remains are found. As already mentioned, they may develop from the branchial clefts, but may also be found in the middle line, or in connection with the thyro-glossal duct. (*b*) The *thyro-glossal duct* (Fig. 261) consists of a tubular outgrowth from the embryonic pharynx passing downwards behind the body of the hyoid bone in front of the larynx and trachea as far as the isthmus of the thyroid gland, which is subsequently developed from it, and unites with the lateral lobes, which in turn spring from the deeper parts of the branchial arches. The upper end of this duct is situated at the foramen cæcum of the tongue, and thence traverses the substance of that

organ between the genio-hyo-glossi muscles to reach the hyoid bone. As a rule, nearly the whole of this tube disappears; if, however, the upper part remains unobliterated, a dermoid cyst may originate from it, placed either in the substance of the tongue or immediately below it (see p. 711). If the lower portion remains patent, a cyst may develop containing mucoid or glairy fluid, which, however, is not present at birth. If it bursts spontaneously, or is opened, a so-called *median cervical fistula* results, which requires the same treatment as a branchial fistula, viz., incision, and complete removal or destruction of the epithelial lining. Occasionally accessory thyroid growths develop from the lower end of the thyro-glossal duct, which is normally represented by the pyramid of the isthmus. Such tumours are innocent in nature, and unless troublesome may be left alone. (*c*) *Cystic hygroma* is sometimes congenital, but may also be acquired. It consists of a multilocular swelling, the spaces composing which are due to dilatation of lymphatic spaces, and are filled with serum. The tumour is often of considerable size, with a sinuous, irregular outline, and may produce great deformity

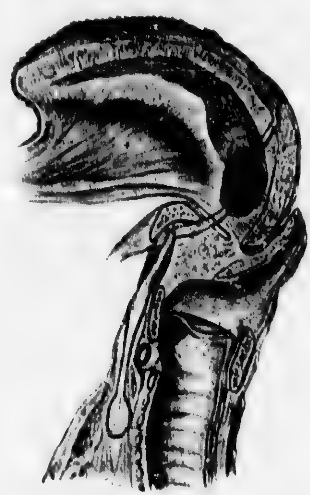

FIG. 261.—MEDIAN SECTION OF TONGUE, LARYNX, AND TRACHEA, SHOWING THYRO-GLOSSAL DUCT EXTENDING FROM THE FORAMEN CÆCUM OF TONGUE DOWNWARDS BEHIND THE HYOID BONE, AND IN FRONT OF THE TRACHEA TO THE ISTHMUS OF THE THYROID BODY. (SEMI-DIAGRAMMATIC, FROM COLLEGE OF SURGEONS' MUSEUM.)

A small dermoid cyst in the centre of the tongue is also represented.

and marked pressure effects. They are not confined to this region of the body. Unless they extend to inaccessible parts, such as the superior mediastinum, they should be dealt with by excision. In the limbs, all that may be required is a firm bandage.

2. **Acquired Cysts of the Neck** are of the following types: (*a*) *Sebaceous cysts* develop in the skin as elsewhere, but need no separate notice here. (*b*) *Bursal cysts* are stated to occur in connection with the larynx and hyoid bone. There is usually a bursa over a prominent pomum Adami, and this may become enlarged and distended with fluid. It is doubtful whether a bursa exists between the back of the hyoid bone and the thyroid cartilage, as was formerly described; cysts containing serous fluid are certainly met with in this situation, but may possibly be of thyro-glossal origin. In doubtful cases a microscopical examination of the lining wall will readily settle the diagnosis, since if it is bursal in origin it is lined with endothelium, whilst if it is thyroglossal it is lined with epithelium. In the former case incision and drainage may suffice to bring about a cure, although excision is preferable; in the latter case the lining wall must be removed. (*c*) *Unilocular serous cysts* are sometimes met with in the lower part of the posterior triangle, constituting the condition known as 'hydrocele of the neck.' They contain serous fluid, with perhaps an admixture of blood. Their origin has not been defined with any certainty, but they are probably due to a dilatation of the lymph spaces, and may be cured by injection of iodine after tapping, or excision. (*d*) *True hydatid cysts* also occur in this region (see p. 170). (*e*) *Blood cysts* have been found in close connection with the large vessels of the neck. They are possibly due to the dilatation of a vein, and may communicate or not with some vascular channel, such as the jugular, and may then be partly emptied on pressure. Where no communication with a venous trunk exists, the lining membrane is intensely vascular. In the former case they may be treated by dissection, securing the vessels with which they communicate above and below; in the latter tapping and injection of perchloride of iron will suffice. (*f*) Cysts are also occasionally met with in connection with the *salivary* glands and the *thyroid* body. (*g*) *Malignant cysts* arise, as already mentioned, from the remains of the branchial clefts, or from a degeneration of epitheliomatous lymphatic glands. They are often of large size, and their removal is impracticable owing to the adhesions which they contract to the deeper structures.

Cut Throat.

Injuries of the neck are commonly met with in cases of attempted homicide or suicide, and vary much in severity according to the extent and position of the wound. If the front of the neck is mainly involved, the air-passages are laid open and the patient's life, though much endangered, is not necessarily destroyed. If, however, the wound mainly affects the side, the great vessels and nerves may be divided, and death from hæmorrhage is very liable to ensue. The course and treatment of the latter class of case require no particular notice, since the general principles relating to all wounds must be adhered to. Where, however, the air-passages have been opened, special conditions and complications arise, requiring suitably modified treatment.

Wounds involving the Air-passages, the result of cut throat, may be located at four different levels: (*a*) above the hyoid bone, encroaching on the base of the tongue; (*b*) through the thyro-hyoid space, the most common situation; (*c*) into the larynx; and (*d*) opening or dividing the trachea.

The **immediate effects** of such lesions may be due to either shock, hæmorrhage, asphyxia, or the entrance of air into veins. *When above the hyoid bone*, the root of the tongue and submaxillary region are involved, and hæmorrhage from the lingual or facial arteries or their branches follows; if the wound extends far enough, the main vessels are divided, and death results. In the less severe cases the patient runs considerable risk of being suffocated by the epiglottis and base of the tongue falling back over the larynx. Much difficulty will be met with subsequently in feeding the patient, owing to impairment of the movements of the tongue. When the *thyro-hyoid* space is opened, the origins of the facial and lingual arteries are again in danger, as also the upper part of the superior thyroid. The base of the epiglottis is divided, and portions of mucous membrane around the entrance of the larynx may be detached, and cause obstruction to respiration. Blood may also trickle down the larynx into the trachea, and lead to asphyxia. Wounds of the *larynx* are usually transverse, and not very extensive, owing to the resistance offered to the knife by the cartilage. The thyroid body may be wounded and bleed freely, otherwise there is but little hæmorrhage. Blood may find its way into the trachea or lungs, and asphyxiate the patient. When the *trachea* is involved, the common carotid and inferior thyroid vessels are very liable to be wounded, giving rise to severe, if not fatal, hæmorrhage. Asphyxia may be brought about by displacement of the severed portions of the tube, or from the entrance of blood into the air-passages, whilst air may also be sucked into opened veins. The recurrent laryngeal nerve may be divided, causing paralysis of the intralaryngeal muscles.

The **secondary effects** following cut throat are mainly inflammatory in origin. (*a*) Any form of *septic inflammation* may occur in the wound, possibly giving rise to cellulitis, which may spread downwards to the mediastinum. Where it involves the tissues above the entrance to the larynx, œdema of the glottis may be produced. Secondary hæmorrhage may also arise from this cause, and even general pyæmia. (*b*) *Inflammation of the air-passages*, tracheitis, bronchitis, or broncho-pneumonia, frequently follows, partly as a result of the entrance of cold air, partly from the admission of septic material, such as food, decomposing blood-clot or discharges. The patient manifests the usual phenomena of such conditions, and may become cyanosed from the obstruction caused to the respiration. In consequence of this partial asphyxia, the sensibility of the mucous membrane of the glottis is diminished, allowing of the passage into it of food which appears at the mouth of the wound; in some cases this may have arisen from division of the superior laryngeal nerve, but the depth at which this structure is situated in the neck makes it difficult to conceive how it could be divided without injury to the main vessels. (*c*) *Surgical emphysema*, or the entrance of atmospheric air into the cellular tissue, may also follow a wound involving the air-passages. It is not limited to the neck, but extends to the trunk, being recognised by the puffy distension of the part, and by a soft crackling crepitus elicited on pressure. It is of no great consequence, and usually disappears in the course of a few days. (*d*) *Septic traumatic fever* is almost always present in these cases, the temperature varying with the extent of the inflammation in the cellular tissue or in the lungs.

The **Treatment** consists in securing all bleeding-points, if possible, but occasionally they are placed so deeply that it is necessary to tie the external carotid. General oozing from the surface must be attended to, for fear of blood being sucked into the air-passages; if it persists after thoroughly opening the wound and exposing it to the cold air, it must be checked by sponge pressure. Every attempt should be made to render the wound aseptic, and if there is a reasonable prospect that this has been attained, it may be closed by sutures in the ordinary way. Where, however, asepsis is doubtful, only the ends of the incision should be drawn together, the central portion being left open.

The treatment of the air-passages will vary somewhat with the site of the lesion. If the trachea has been divided, the portions should be steadied by a stitch on either side, and a tracheotomy-tube inserted—at any rate for a few days; in some cases where cleanly cut, total closure without the use of a tube can be effected. When the wound involves the larynx, it may be possible to treat the case in the same way, since the larynx does not readily tolerate the presence of a tube; if it is necessary to introduce one, it is better to perform a high tracheotomy. When the wound involves the thyro-hyoid space, or is situated above the hyoid bone, the best practice consists in opening the upper part of the trachea and inserting a Hahn's tube, so as to minimize the risk of septic pneumonia from the passage of food and discharges, as also to prevent asphyxia from œdema of the glottis. The upper wound may then be closed by successively suturing each layer. The mucous membrane should first be closed by stitches which do not penetrate its whole thickness, and then a more thorough purification of the wound can be undertaken. If the epiglottis is divided, it must be accurately sutured.

In every instance the head should be flexed on the chest, and in suicidal cases a careful watch maintained to prevent the patient tearing the wound open. Extreme shock from loss of blood is dealt with by the infusion of saline solutions, and the patient's general health attended to. Feeding should always be undertaken through a tube passed into the œsophagus, whether that structure is wounded or not, and such should be continued until the patient's natural powers of swallowing are restored.

The following **Sequelæ** occasionally result from a cut throat: (*a*) An *aërial fistula* is the term applied to a persistent communication between the air-passages and the external air, and occurs most often in the thyro-hyoid space, the skin and mucous membrane uniting one to the other around the margins of the opening. In some cases it may be closed; but if laryngeal stenosis or adhesions are present, it must be left alone for a time until these conditions have been treated. The operation consists in separating the skin from the mucous membrane, and in order to accomplish this, the external wound must be enlarged vertically. The edges of the mucous membrane are then pared, and stitched together horizontally. The external wound is either left open to allow of the escape of air and discharge, or may be partially closed, and a drainage-tube or gauze stuffing inserted. (*b*) *Laryngeal or tracheal stenosis*, due to the cicatrization of wounds in these regions, may be remedied by wearing an O'Dwyer's tube (p. 778) for a time, or may necessitate the constant use of a tracheotomy-tube if it cannot be dilated. (*c*) *Aphonia* may arise from division of the recurrent laryngeal nerve, and is then usually persistent. (*d*) *Œsophageal or pharyngeal fistulæ* may also in rare instances complicate the healing of an extensive wound in the throat, but tend to close of themselves, and require no special treatment.

Tumours of the Neck.

Solid Tumours of the neck are of very variable nature, almost any form of neoplasm being met with, the great majority, however, arising from the lymphatic glands, tubercular enlargement and lymphadenoma being the most common. Malignant disease of several types also occurs, *e.g.*, lympho-sarcoma; epitheliomatous deposits in the glands secondary to disease of the tongue or tonsil, such often becoming cystic; and primary branchial carcinoma. It is important to ascertain, if possible, from what structures the growths arise, and whether or not they are of a malignant nature. Early fixation of the growth to the deeper structures, lack of definition of the outline, severe pain and rapid growth, all point towards the latter conclusion. As to removal, the fixity or not of the mass to the deeper parts is the all-important matter to decide. The most extensive operations may be undertaken for the removal of tubercular or lymphadenomatous glands, including even the division of the sterno-mastoid; but where the mass is ill defined and adherent to the deeper parts, and evidently of a malignant nature, it should be left alone.

Diseases of the Thyroid Body.

Goitre.—Enlargement of the thyroid body, or, as it is termed, bronchocele or goitre, is a condition frequently seen in this country, and to which much attention has been directed of recent years, owing to the discovery that the thyroid body exercises considerable influence over the metabolism and nutrition of the body. Total absence of the gland is associated with the disease known as myxœdema, or cachexia strumipriva, whilst recently it has been suggested that the symptoms of Graves' disease are due to the excessive absorption of normal or vitiated thyroid secretion.

The **Causes** of bronchocele are still enshrouded in a good deal of uncertainty. The disease occurs endemically in this and some other countries, being especially frequent in the hilly parts of Derbyshire and Gloucestershire (and known, in fact, as Derbyshire neck), whilst it is also exceedingly common in Switzerland. The old idea that it occurs more frequently in places located on chalk or magnesian limestone is not true, it being more common, perhaps, in regions where the green sandstone and carboniferous limestone crop up. Possibly the disease is due to the presence or absence of some mineral constituent of the drinking water, and the recent discovery made by Baumann, of Friburg, suggests that an absence of iodine is the cause of the trouble. At any rate, iodine is to be found in the normal thyroid secretion in close combination with albumin, whilst it is absent in cases of goitre, the enlargement of the gland being looked on in the light of a compensatory hyperplasia. Other causes which have been suggested are want of sunshine and air, as in the case of individuals who live in valleys into which the air does not readily penetrate, or in the underground kitchens and cellars of large towns, defective sanitary conditions, and the habit of carrying weights upon the head, also possibly assisting. In the form ordinarily met with, it is not hereditary, and is not influenced by intermarriage; but it may be congenital, and if associated with skeletal changes, defective growth, and intellectual weakness, constituting the condition known as cretinism, it certainly runs in families. The ordinary type of goitre seen in this country is much more common in women than in men.

Varieties and Clinical Features.—Four chief forms of goitre are described, viz.: The parenchymatous or simple, the cystic, the fibro-adenomatous, and the exophthalmic; but the thyroid body may become enlarged in other ways, giving rise to the conditions known as malignant goitre and acute goitre, whilst acute inflammation is sometimes seen.

General Features.—In all these cases the thyroid body is the site of a swelling involving its whole substance, or one or other of its lobes, or possibly the isthmus alone. Its consistence varies with the nature of the growth, but it always moves with the larynx on deglutition. In every form there is probably a certain amount of anæmia, whilst some of the symptoms characteristic of the exophthalmic variety are often produced even in simple cases, possibly from the excessive absorption of thyroid secretion. Pressure on surrounding structures leads to dyspnœa, and cerebral symptoms may arise from interference with the main vessels, which are displaced outwards. The trachea is especially liable to changes of situation and shape from its compression; it is usually flattened from side to side, and is sometimes pushed an inch or more from the middle line (Fig. 264); atrophy of the cartilaginous rings may also be induced. Pressure on the recurrent laryngeal nerve leads to harshness in speaking or aphonia, and to spasmodic attacks of dyspnœa, which may even prove fatal. In cases where the growth is large and firmly bound down, dysphagia forms another pressure symptom.

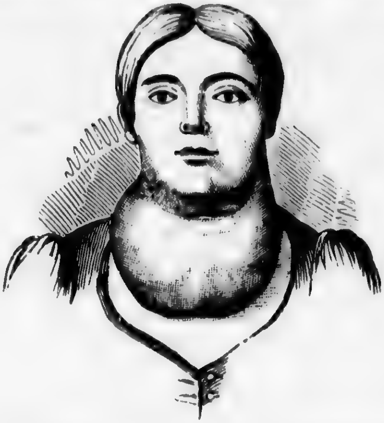

FIG. 262.—LARGE SIMPLE OR PARENCHYMATOUS GOITRE INVOLVING THE WHOLE GLAND.

Simple or Parenchymatous Goitre (Fig. 262) consists of a diffuse overgrowth of the whole thyroid body, the parts retaining to a great extent their usual proportions. The acini are not markedly enlarged, but contain colloid material, and there is a normal amount of fibrous stroma present. The whole gland is usually involved, but possibly one lobe is larger than the other. It is soft and elastic to the touch, quite painless, and unless large gives rise to but little inconvenience. It consists of a diffuse hypertrophy, with perhaps some new formation of an adenomatous type. When the interstitial tissue is abnormally abundant, as often occurs in the later stages, the tumour feels harder than usual, and is often lobulated. It is then termed a *fibrous goitre*, and if the sclerosis is very marked, myxœdema may supervene.

Cystic Goitre (Cysto-adenoma) arises from the dilatation of some of the alveolar spaces into cysts. They may be single or multiple, and contain either a thin fluid or a thick grumous colloid material, somewhat like furniture polish. Intracystic growths of a papillary nature are not unfrequently met with. The lining membrane of these cysts is epithelial in nature, the individual cells being cuboidal when the cyst is small, and flattened out or squamous when large. It is sometimes intensely vascular, and hæmorrhage into the cysts is by no means uncommon, causing the contents to be brown or blood-stained.

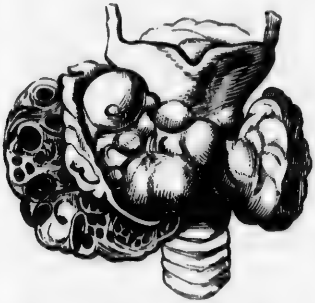

FIG. 263.—DIFFUSE FIBRO-ADENOMATA OF THYROID BODY WITH A TENDENCY TO BECOME CYSTIC.

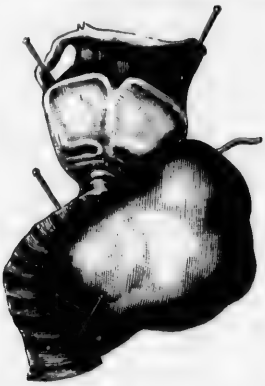

FIG. 264.—LARGE UNILATERAL GOITRE DISPLACING THE TRACHEA TO THE RIGHT, AND COMPRESSING IT LATERALLY TO A SERIOUS EXTENT. (TILLMANNS.)

The **Fibro-adenomatous Goitre** is characterized by the development of one or more localized tumours, similar in nature to the rest of the gland, in which it is embedded. It is usually distinctly encapsuled, and several such growths may be present (Fig. 263). It is recognised from simple hypertrophy of the gland by being more distinctly localized, unilateral, or central, and sometimes projecting as a globular mass from the body of the gland. It grows slowly, and is simple in nature. If embedded deeply in the substance of the organ, it may produce an appearance of general enlargement, and may not be recognised till after removal. The isthmus is, perhaps, one of the commonest situations for these adenomata.

Secondary changes occur in any of these varieties, chiefly affecting the interstitial tissue, which may develop into cartilage or bone, or may calcify, but only in very chronic cases. Hæmorrhage into the alveolar spaces or cysts is not uncommon; acute infective inflammation may also involve the mass, and malignant disease, usually of a cancerous nature, sometimes supervenes.

The **Treatment** of the three preceding forms of goitre may be considered together, as they are very different in nature to those which follow. In the early stages palliative measures can be employed, consisting in the improvement of the general health and the correction of errors in the personal and sanitary hygiene. A change of air to the seaside is often advisable, whilst iron and iodide of potassium may be administered internally, and iodine paint or iodide of potassium ointment applied locally. In India cures are often produced by inunction of iodide of mercury ointment, the part being subsequently exposed to the rays of the mid-day sun; such treatment is generally impracticable in this country. The deficient amount of iodine present in the gland in these cases explains why this drug is so pre-eminently useful, and it has been found that the active principle of the gland isolated by Baumann and called 'thyro-iodine' is the best form in which it can be administered. The exhibition of thyroid extract is sometimes followed by a diminution of a simple goitre, and the same explanation of its value probably holds good.

In cases where, in spite of such treatment, the growth persists or increases in size, other measures must necessarily be employed, and there is no doubt that removal of the tumour or of a part of the gland is the best practice to adopt. Total extirpation, as already mentioned, results in myxœdema; but as long as a sufficient portion of the secreting substance is left, whether it is derived from the isthmus or from one of the lobes, no such accident need be feared. The operation necessitates a somewhat deep dissection, and will encroach on important structures; but with due care, and the maintenance of efficient asepsis, the most satisfactory results are obtained, except when the growth is of very great dimensions. We would particularly emphasize the fact that goitres should be treated in the same way as other new growths, viz., by removal when small. There is still unfortunately a considerable tendency amongst practitioners and patients to leave them untouched until they are of large size, thus greatly increasing the risk of the operation. Other plans of treatment have been utilized in the past, *e.g.*, ligature of the thyroid vessels, division of the isthmus, curetting the mass with a large Volkmann's spoon, passage of a seton, or intraglandular injection of irritants, such as tincture of iodine; but they should be entirely discarded in favour of more radical measures.

Partial thyroidectomy (or Kocher's operation) is conducted as follows: An incision is made over the most prominent part of the tumour, preferably along the lower third of the anterior border of the sterno-mastoid. Kocher recommends a transverse or angular incision, and this may be employed in suitable cases. The platysma and deep fascia are divided, the sterno-mastoid drawn outwards, and the sterno-hyoid, sterno-thyroid, and omo-hyoid displaced inwards, or, if need be, divided. The lobe to be removed is thus exposed within its capsule, which should not be opened. The limits of the mass are clearly defined by the finger or a blunt dissector, and the vessels entering or leaving it are secured. The superior thyroid vessels are doubly ligatured and divided at the upper end of the growth, the middle thyroid vein is secured at the middle of its outer border, whilst the inferior thyroid vessels are dealt with below, special care being taken not to injure the inferior or recurrent laryngeal nerve by tying the vessels as near to the gland as possible. The lobe is now freed from the underlying structures, as also the isthmus from the trachea. In detaching the latter, the surgeon must not forget that the cartilaginous rings may have been absorbed, and that the walls of the trachea, being then merely fibrous in nature, are easily wounded. The isthmus should be transfixed and tied in two halves with a silk ligature, so as to prevent hæmorrhage. The growth can now be removed, the bleeding points secured, and the wound closed, the muscles and fascia being drawn together by buried catgut stitches. A drainage-tube is best inserted for 24 or 48 hours, as it is difficult to employ much pressure on the neck, but this precaution may sometimes be omitted. Healing by first intention should be the invariable result.

Cystic goitre is treated in the same way as fibro-adenomata by enucleation, although if several cysts are present removal of the affected lobe may be necessary. The old line of practice, which is still occasionally in vogue, consists in tapping with a full-sized trocar and cannula, and injecting with tr. ferri perchlor. or iodine. Good results have followed these measures, but occasionally the relief of tension within the cyst has given rise to severe hæmorrhage from its walls, which threatens the patient's life. In such cases the cyst should be laid freely open, and the cavity plugged with sponges or gauze soaked in some strong hæmostatic; or it may be feasible to rapidly enucleate the whole cyst, and thus command the hæmorrhage by ligaturing the supplying vessels.

Fibro-adenomata, when multiple, are treated by extirpation of the affected lobe; but if the new growth is single and easily recognisable, its enucleation should be undertaken (*Socin's operation*). The skin and muscles are divided as before, and the gland substance and capsule incised down to the growth, which is readily shelled out.

Exophthalmic Goitre, or, as it is often termed, Graves' or Basedow's disease, is a condition characterized by a diffuse enlargement of the thyroid body, which often pulsates forcibly owing to the dilatation of the vessels (particularly those in the capsule), associated with marked anæmia, severe palpitation and cardiac irritability (tachycardia), and protrusion of the eyeball (exophthalmos or proptosis). The nature of the disease has long been a topic of discussion, one of the earliest ideas being that it results from some derangement of the sympathetic nervous system, or possibly of the medulla. Lately, however, owing to the fact that in cases where thyroid extract has been given to excess, symptoms somewhat akin to those seen in this condition have arisen, it has been suggested that the disease is due to the excessive absorption of thyroid secretion, although why it occurs in some cases of enlargement, and not in others, has not been explained. In all probability the truth lies half-way between the two theories, the enlarged thyroid and some of the symptoms being alike due to some central disturbance in the upper part of the medulla, whilst others are due to excessive absorption of thyroid secretion.

The patients usually affected are females, about the middle period of life, whose menstrual functions are often impaired. Overwork, worry, and severe mental strain, are apparently responsible for the onset of the symptoms in many instances, and a sudden shock or fright accounts for others. The protrusion of the eyeball is a marked feature of the case, and has been supposed to be due to the increase of the orbital fat, but this is very doubtful. Contraction of the so-called muscle of Müller (unstriped muscular fibres stretched across the spheno-maxillary fissure) has been suggested as a more plausible theory. When the patient looks down, the upper eyelid does not immediately follow the eyeball, allowing the white sclerotic to be seen between the lid and the cornea (von Graefe's sign). A fine fibrillary tremor of the limbs is also commonly observed in these cases. The patient is always extremely nervous, and the pulse-rate high; any exertion or excitement increases the irritability of the heart's action, and may also induce considerable respiratory distress. Left to itself, the disease in some cases tends to improve, but in others it may progress to a fatal issue from asthenia or cardiac complications.

8 lines

Treatment must, in the first place, consist in freeing the patient, if possible, from all sources of worry, whilst bromides, iron, and perhaps iodide of potassium, are administered internally, attention being also directed to correcting menstrual derangements, or any other abnormalities of function or structure occurring within the body; thus, the cure of a nasal catarrh by cauterizing the nasal mucosa has several times led to a rapid amelioration of the symptoms. Phosphate of soda has lately been much commended in this disease, and Kocher speaks favourably of it when conjoined with suitable hygienic measures. Thymus extract has also proved beneficial.

Since the introduction of the theory that the derangement is mainly thyroidal in origin, surgical treatment by removal of a portion of the gland has been suggested, and the results gained so far have been encouraging, although the proceeding is not devoid of serious risk, and should not be lightly undertaken. As a rule, half of the gland has been removed, but some surgeons have been satisfied with tying three of the thyroid arteries in order to starve the growth. The patients never take an anæsthetic well, and several fatal results have ensued from this cause. They are also very liable to syncope after the operation, and occasionally a curious train of symptoms supervenes within a few hours. The temperature rises suddenly to 104° or 105°, the pulse-rate is greatly accelerated, and the patient becomes delirious, and finally comatose, dying in that state in about forty-eight hours. It is supposed that excessive thyroid toxæmia is responsible for these phenomena. In the cases that recover, a gradual improvement usually shows itself, and the full benefit of the operation is rarely gained under six or twelve months; even then the exophthalmos often persists. It is a little doubtful whether the benefits are really to be ascribed to the operation, or to the improved environment necessitated by it. The symptoms sometimes recur at a later date, and such cases have been treated by removing another portion of the gland.

Malignant Disease of the Thyroid Body is more frequently cancerous in nature than sarcomatous, usually taking the form of an adenoid cancer, and always preceded by simple enlargement of the gland. The tumour grows rapidly, infiltrating the surrounding parts, and causing enlargement of the lymphatic glands, and secondary deposits in the viscera and elsewhere. The trachea is severely compressed, and in some cases perforated by the growth. The secondary deposits frequently affect osseous tissues, constituting pulsating tumours exactly simulating thyroid tissue in nature. Myxœdema may arise as a complication of this affection, owing to the total destruction of the glandular substance. Treatment by extirpation can only be undertaken in the early stages.

Acute Goitre is but rarely met with, consisting of a rapid enlargement of the thyroid body, which attains a considerable size in the course of a few days or weeks. It usually affects young subjects, and is generally fatal from asphyxia due to pressure on the trachea or spasm of the glottis. Comparatively little can be done for such cases; incisions into the fascia, division of the isthmus, and tracheotomy, have been suggested. In the latter case it may be necessary to have a specially long tube, which can be passed for some distance down the trachea.

Inflammation of the Thyroid Body, or acute thyroiditis, occasionally supervenes as a complication of an ordinary goitre. It is almost always infective in nature, the cocci reaching it from without, as in a punctured wound, or from within the body in a pyæmic embolus, suppuration being usually induced; it sometimes follows a blow, and may then be simple. The gland becomes enlarged, hot and tender, fever and rigors follow, and the presence of pus is evidenced by superficial œdema and fluctuation. The early treatment consists in the use of hot fomentations, with perhaps leeches. The patient is kept in bed, purged, and carefully dieted. Under such a regime, resolution may occur; but if, as happens more frequently, pus forms, a free incision should be made.

Accessory Thyroids sometimes develop above or below the isthmus, or closely attached to one of the lateral lobes. They are recognised by their connection with the thyroid body, moving up and down with it on deglutition, and if troublesome may be removed.

CHAPTER XXVII.

SURGERY OF THE AIR-PASSAGES, LUNGS, AND CHEST.

Foreign Bodies in the Air-passages.

Any part of the respiratory tract may be partially or completely obstructed by the presence of some foreign body, the effect of which may be of greater or less gravity according to the situation, character, and size of the intruding substance.

1. **In the Nasal Passages**, see p. 685.

2. Obstruction occurring **at the Rima Glottidis**, or pharyngeal entrance to the larynx, is usually due to attempts to bolt large masses of food, which, becoming impacted, may cause immediate death. A person eating a meal voraciously turns black in the face and falls off his chair, dead. A similar result has followed such a foolish act as attempting to swallow a billiard ball. If the obstruction is not complete, as when a plate of false teeth becomes impacted, great dyspnœa is caused, and absolute inability to swallow, the symptoms rapidly increasing owing to œdema of the submucous tissue of the glottis. Accidents of a similar nature may occur during chloroform narcosis, an epileptic fit, or drunkenness, some such substance as a plate of teeth being dislodged from the mouth, or a mass of food being vomited, and blocking the entrance to the larynx. The **Treatment** of such cases must be very prompt, since there is no time to lose. The mouth should be forced open by the handle of a fork or anything suitable that happens to be near, and the finger rapidly swept round the pharynx so as to dislodge any foreign body present. Failing this, laryngotomy must be performed at once, and artificial respiration, if necessary, instituted. In less urgent cases there is time to remove the substance from the mouth with the assistance of a frontal mirror.

3. **In the Larynx.**—A foreign body enters the larynx by inhalation during a deep inspiratory effort, when the glottis is widely open. Anything large is likely to be stopped above the larynx, and hence the type of foreign bodies we find in this region consists of small coins, buttons, nutshells, or a small tooth-plate. It may

cause total obstruction and immediate death, or may enter one of the ventricles, and only produce partial obstruction, as evidenced by a sudden sense of suffocation, urgent dyspnœa, and a violent attack of coughing, attended perhaps by vomiting, such as occurs when anything is said to have 'gone down the wrong way.' The voice becomes croupy and hoarse, respirations stridulous, and any movement of the patient may for some time bring on a spasmodic fit of dyspnœa. After a while the obstruction, which is at first partial, may become complete from œdema of the glottis, whilst perichondritis and ulceration or necrosis of the cartilages may be induced. Laryngoscopic examination should reveal the situation of the intruding body. The **Treatment** consists in attempting to remove it through the mouth with suitably curved forceps guided by a laryngoscope (endo-laryngeal method); or, failing that, a laryngotomy is performed, and the body dislodged if possible from below. Should this not be successful, thyrotomy (p. 769) must be undertaken.

4. **In the Trachea.**—A foreign body must be small enough to pass through the glottis, and not too heavy, otherwise it will drop into one of the bronchi; possibly, if it has jagged edges, it may become impacted, but is not uncommonly free. It may remain tolerably quiet at one spot, only moving when the patient alters his position or coughs; but the longer it remains, the less moveable it is, owing to its becoming embedded in mucus.

The **Symptoms** may be classed as those of obstruction, irritation, and inflammation. During the passage of the body through the larynx, the patient suffers from a severe attack of spasmodic dyspnœa and coughing, which may last for some time. Later on similar attacks may be induced by the foreign body being coughed up against the lower aspect of the vocal cords, and death has even resulted from its impaction in the larynx brought about in this way. The irritation of the unusual occupant of the trachea produces a good deal of tracheitis, with frothy expectoration and spasmodic cough; but the lower it lies, the less the irritation, the mucous membrane being apparently less sensitive as it descends from the larynx. **Treatment** consists in performing a low tracheotomy with a good-sized opening, and if possible removing the intruding body at once, if it can be detected; or the patient may be inverted and the back well concussed in order to dislodge it. Failing this, the wound in the trachea must be left widely open, by inserting a wire stitch through each side of the incision and tying them behind the neck; very probably the body will be expelled through it during an attack of coughing.

5. To become impacted in a **Bronchus**, the foreign body must be small enough to pass through the rima glottidis, and heavy and smooth enough to allow of its dropping down the trachea; the most common articles met with are buttons, pebbles, slate pencils, an O'Dwyer's tube, or the inner cannula of a tracheotomy-

tube. Usually it is the right bronchus that becomes obstructed, the reason for this being that although the left bronchus is more in a direct line with the trachea, yet the right is the larger, the septum between them lying to the left of the middle line. A similar series of symptoms manifest themselves as those described above, viz., obstruction, irritation, and inflammation. The obstruction is twofold: immediate, as a result of the passage of the body through the glottis, a condition due more to spasm than to mechanical causes; and late, as a sequence of its lodgment in the bronchus. Even if at first the obstruction is partial, it soon tends to become complete from swelling of the mucous membrane; for a time it is more or less valvular in character, allowing exit to air during expiration, but absolutely preventing its entrance. Collapse of that portion of the lung supplied by the affected bronchus is thus induced, as indicated by dulness and the absence of breath-sounds. Irritation and inflammation soon follow, resulting in bronchitis, the formation of a bronchi-ectasis, and peri-bronchial pneumonia; suppuration ensues, and the foreign body may be expelled sooner or later, with a sudden gush of pus during a fit of coughing. Thus, in a case treated by the late Mr. William Rose (grandfather to one of the authors*), a beech-mast was inhaled in November, 1812, and was not extruded till May, 1822, the patient having in the meantime evidenced all the symptoms of a bronchi-ectasis. Sometimes the abscess may extend through the lung substance to the pleura, setting up a localized empyema, through which, when opened, the article is expelled. In other cases the lung becomes riddled with abscesses, and the patient dies from exhaustion.

Treatment.—The position of the foreign body must be, if possible, ascertained by careful examination of the lungs, which may reveal the existence of a certain amount of collapse, whilst skiagraphy may also be useful in certain cases. A low and extensive tracheotomy is then performed, and the bronchi examined by a long bullet probe, suitably bent. The foreign body may thus be felt, and its removal accomplished by a delicate pair of forceps, a loop of wire, or a coin-catcher. Abscess of the lung, and localized empyema, must be dealt with by incision, and it is possible that the foreign body may be removed by this means through the thoracic parietes.

Injuries of the Larynx.

Several conditions arising from traumatism of the upper air-passages have been already described, *e.g.*, fracture of the hyoid bone (p. 382), and incised wounds, as in cut throat (p. 752).

Occasionally the thyroid or other cartilages may be injured or fractured from direct violence, as in garrotting, causing local pain and hæmorrhage, and possibly some obstruction to the respiration. As a rule, no treatment is required beyond keeping the patient quiet, but should symptoms of dyspnœa arise, intubation or tracheotomy must be had recourse to.

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* *Lancet*, August, 1843.

Diseases of the Larynx.

The study of laryngeal diseases can only be briefly referred to here, since the subject is now such a wide one as to require special text-books.

Before the student can understand the subject, it is absolutely essential for him to master the use of the *laryngoscope*. This consists of a circular mirror, set at an angle on the end of a metal stem, which is inserted into the patient's widely-opened mouth in such a way that it rests against, and slightly elevates, the soft palate. A beam of light is thrown into the mouth, either from an electric head-lamp on the surgeon's forehead, or reflected by a frontal mirror from a suitable source of illumination. The patient's tongue, held with a towel, is drawn well forwards so as to enable the light to reach the larynx, the image of which is seen in the mirror. Considerable practice is needed in order to attain any facility in the use of this instrument, as also to be able to recognise normal from abnormal structures. The use of cocaine to anæsthetize the fauces is in many cases indispensable. It must be remembered that the image is always inverted, so that the anterior portion of the larynx appears behind, but there is no reversal of the sides.

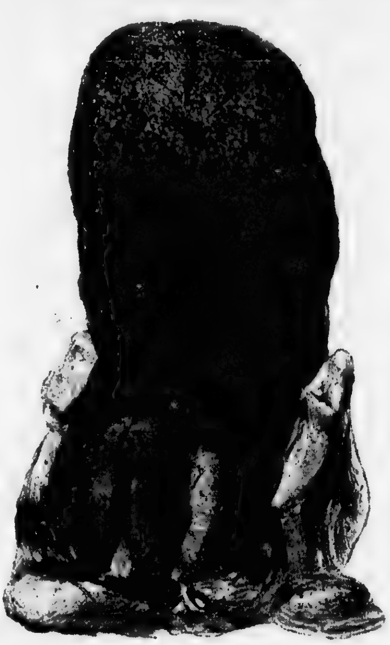

FIG. 265.—ŒDEMA OF GLOTTIS AND TONGUE FROM BEHIND. (COLLEGE OF SURGEONS' MUSEUM.)

The tongue is seen to be enlarged and swollen, and the aryteno-epiglottidean folds are œdematous, so that the entrance to the larynx is represented by a mere chink.

Acute and Chronic Laryngitis are conditions of but slight surgical interest. The acute affection arises from cold, or over-exertion of the vocal apparatus, and is characterized by aphonia (loss of voice) and cough. Locally, the vocal cords are seen to be hyperæmic and swollen. The *Treatment* is rather medical than surgical, although in children intubation or tracheotomy may be sometimes required.

Diphtheritic Inflammation of the Larynx is usually met with as an extension of a similar affection of the fauces. It gives rise to severe dyspnœa from obstruction in the rima glottidis, and, if the condition does not yield to the injection of the diphtheritic antitoxin, will probably call for intubation or tracheotomy.

Acute Œdematous Laryngitis, or œdema of the glottis, is a condition of considerable surgical importance. *Causes.*—(*a*) It is either secondary to some other laryngeal affection, such as acute catarrhal laryngitis, or acute perichondritis; or (*b*) may extend from inflammatory conditions of neighbouring tissues, such as the root of the tongue, or the submaxillary region, as in cellulitis or Ludwig's angina; or it may be secondary to a retropharyngeal abscess. (*c*) It is also not unfrequently seen in children from drinking scalding water, as from the spout of a kettle, or sometimes in adults from swallowing corrosives. (*d*) It may result from the presence of a foreign body. *Characters.*—The folds of mucous membrane extending on either side of the epiglottis both to the root of the tongue and backwards to the arytenoid cartilages become swollen and œdematous from a serous effusion into the submucous tissue (Fig. 265). The same condition also involves the interarytenoid fold, and the false vocal cords (superior thyro-arytenoid folds) extending down as far as the true cords. The process is checked at this level owing to the absence of submucous tissue, the vocal cords consisting of elastic fibres, merely covered with a layer or two of squamous epithelium. The epiglottis becomes folded laterally upon itself as a leaf, constituting a valve-like opening which permits of expiration, although considerably checking inspiration. The *Symptoms* produced by this condition are those of mechanical dyspnœa, to which, not unfrequently, spasm of the glottis is superadded, and this is sometimes of sufficient intensity to destroy the patient's life. There may be also some amount of febrile disturbance. The diagnosis is made, both by passing the finger into the pharynx, when the rigid swollen epiglottis can be felt, or by laryngoscopic examination, when the slit-like opening of the glottis, bounded below and behind by thickened œdematous folds of mucous membrane, can be seen. *Treatment* consists in scarification of the swollen tissues below and behind the epiglottis, which can be effected after spraying the parts with cocaine, either by the finger-nail or with a suitable knife guided by a laryngoscope. The usual result of this is a rapid diminution of the œdema, and additional relief may be gained by inhaling steam arising from boiling water, to which some tinct. benzoini co. has been added. Hot fomentations or iced compresses applied externally are also useful. In more severe cases, and especially in children, intubation may be called for, or the air-passages may be opened below the obstruction, laryngotomy, as a rule, sufficing in adults, but a high tracheotomy being needed in children.

Syphilitic Disease of the Larynx.—In the *secondary* stage, mucous tubercles or superficial ulcers occasionally form in the neighbourhood of the vocal cords, concurrently with the rash on the skin, and the formation of condylomata and mucous tubercles elsewhere. It is very likely to occur in costermongers, or those who have to speak loudly, and may then lead to a good deal of thickening of the cords. Apart from such cases, it rarely causes much trouble beyond a little hoarseness. No special treatment is required, although possibly the parts, if ulcerated, may be brushed over with a solution of perchloride of mercury. In the *tertiary* period, diffuse gummatous infiltration or localized gummata may develop, giving rise to destructive ulceration, which especially affects the epiglottis and aryteno-epiglottidean folds, and may spread backwards and involve the whole glottis (Fig. 266). Inflammation of the perichondrium is likely to follow, leading to necrosis of the cartilages. Hoarseness and dyspnœa are the chief symptoms of this affection, whilst later on considerable obstruction may be caused by cicatrization and laryngeal stenosis. *Treatment* consists in the administration of iodide of potassium and mercury, whilst ulcers may be sprayed with perchloride of mercury solution, or dusted over with calomel or iodoform. Should urgent dyspnœa arise, tracheotomy must be undertaken.

Tubercular Laryngitis (Fig. 267) is occasionally a primary manifestation of tubercle, but much more frequently secondary to phthisis, arising from infection of the mucous membrane owing to the constant passage over it of infected sputum. It usually commences at the posterior part of the larynx in the neighbourhood of the arytenoid cartilages, as a submucous infiltration, which breaks down, and leads to typical tubercular ulcers, similar to those occurring in other viscera (p. 128). Considerable destruction of tissue ensues, involving the whole circumference of the larynx, and even leading to necrosis and destruction of the cartilages. Hoarseness, cough, and perhaps a certain amount of dyspnœa, in a patient suffering from phthisis are the chief symptoms arising from this affection, the prognosis of which is always of a grave nature. *Treatment.*—In phthisical patients local treatment is of but little avail, but where the disease is primary an attempt should be made to deal with it; such, however, can only be undertaken by the skilled laryngologist, as it consists in the topical application of caustics and antiseptics. Thyrotomy or subhyoid pharyngotomy has sometimes been practised, in order to attain this object more thoroughly.

Paralysis of the Larynx is observed in a variety of conditions, but is only of surgical interest when arising from injury or division of, or pressure upon, the recurrent laryngeal nerve. It may follow such operations as the removal of a goitrous tumour or of tubercular glands, but is most commonly seen in connection with aneurisms of the innominate or aorta, or tumours in the same neighbourhood, *e.g.*, cancer of the œsophagus. Paralysis from the above causes is generally unilateral, but if due to cancer both sides may be involved. The effect of complete paralysis of one recurrent laryngeal is to produce total immobility on the affected side of the vocal cord, which lies in what is known as the 'cadaveric position,' *i.e.*, midway between that in which it is placed during phonation and during inspiration. Not uncommonly, however, the paralysis is incomplete, and then merely affects the abductor muscle (the crico-arytenoideus posticus). The *Symptoms* arising from unilateral recurrent paralysis are often very slight, the voice being usually but little modified, owing to the healthy cord being capable of passing across the middle line. If, however, both sides are affected, absolute aphonia, without dyspnœa, results when the paralysis is complete; but if only the abductors are involved, the voice may be unimpaired, although severe dyspnœa is often present, which may prove fatal unless tracheotomy is promptly performed.

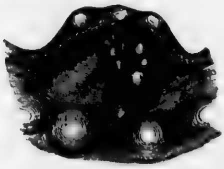

FIG. 266.—GUMMATOUS DISEASE OF THE LARYNX. (TILLMANNS.)

Small gummata are seen invading the mucous membrane of the epiglottis and front of the larynx.

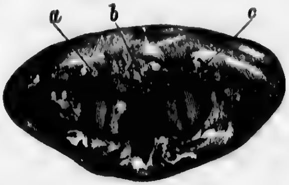

FIG. 267.—TUBERCULAR DISEASE OF THE LARYNX, WITH EXTENSIVE ULCERATION IN FRONT AND BEHIND. (TILLMANNS.)

Tumours of the Larynx.

Several forms of new growth have been met with in the larynx, but it is only necessary here to draw attention to the more important, viz., papilloma and epithelioma.

Papilloma (Fig. 268) occurs in the form of wart-like masses, growing usually from the true vocal cords. They give rise to considerable hoarseness, and perhaps some dyspnœa. They are recognised on laryngoscopic examination, and may usually be removed successfully by laryngeal forceps, after the parts have been efficiently cocainized. It is recommended by some authorities to destroy the growth with a galvano-cautery.

Epithelioma occurs in patients over forty, originating as a papillary overgrowth, usually near the base of the epiglottis, or from the true or false cords (Fig. 269). The tumour gradually spreads, both superficially and deeply, and may invade the cartilages, giving rise to necrosis. At a later stage it extends beyond the limits of the larynx, invading the base of the tongue, œsophagus, and even the lateral walls of the pharynx. In the earlier stages, so long as the disease is strictly limited to the larynx (intrinsic), the growth is often unilateral, giving rise to hoarseness and aphonia, together with an irritable cough, and the expectoration of blood-stained mucus, which may be horribly offensive. This is associated with but little tendency to affection of lymphatic glands or cachexia. When, however, the growth has extended to surrounding structures (extrinsic), lymphatic enlargement follows, and the disease runs its usual course, destroying life by dyspnœa and exhaustion. Pain is often a most distressing symptom, being referred either to the larynx or pharynx, or, according to Ziemssen, not unfrequently to one or other ear. *Treatment.*—In the early stages it is possible that thyrotomy and efficient curetting and cauterization may suffice to bring about a cure. Later on, removal of one or both halves will be requisite, and the operation may even include parts of the tongue and pharyngeal wall. Where, however, the disease has spread more extensively, its total extirpation is rarely practicable, and all that can be done is to treat symptoms as they arise, and perform tracheotomy when necessary.

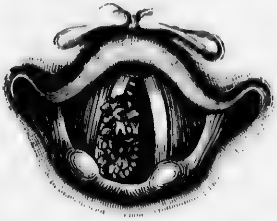

FIG. 268.—PAPILLOMATA OF THE LARYNX, SPRINGING FROM THE RIGHT VOCAL CORD. (TILLMANNS.)

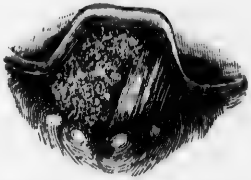

FIG. 269.—EPITHELIOMA OF THE LARYNX, INVOLVING THE RIGHT VOCAL CORD AND BASE OF THE EPIGLOTTIS. (TILLMANNS.)

Operations upon the Air-passages.

1. **Subhyoid Pharyngotomy** is an operation devised by Malgaigne, in order to provide access to the upper parts of the larynx in the treatment of foreign bodies or tubercular disease. A transverse incision is made through the thyro-hyoid space, the pharynx is opened, and the epiglottis detached from the base of the tongue (Fig. 270, I.). It is a proceeding that is seldom undertaken, and scarcely necessary.

2. **Thyrotomy** (Fig. 270, II.) consists in a partial or complete vertical section of the thyroid cartilage, and may be required for the removal of foreign bodies or tumours, or for the radical treatment of laryngeal tuberculosis. Tracheotomy is performed as a preliminary measure, and the trachea plugged around the

tube. An incision is then made in the middle line of the neck, extending from the hyoid bone to the cricoid cartilage. The crico-thyroid ligament is clearly defined and severed transversely, and the thyroid cartilage divided in the middle line by a knife, cutting pliers, or fine saw. The lateral halves are then separated, and the intralaryngeal portion of the operation proceeded with. When closing the wound, the greatest care must be taken to bring the sides accurately together, so that the vocal cords may be exactly opposite each other, otherwise phonation may be considerably impaired. This is best accomplished by nicking the cartilage transversely before dividing it.

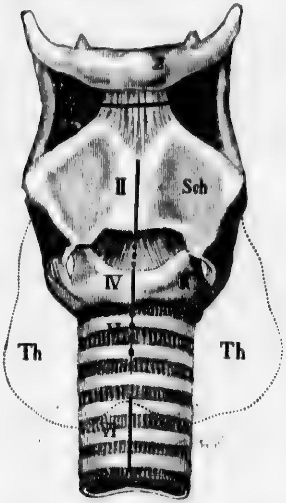

FIG. 270.—OPERATIONS ON THE AIR-PASSAGES. (TILLMANNS.)

I., Subhyoid pharyngotomy; II., thyrotomy; III., laryngotomy; IV., cricotomy; V., high tracheotomy; VI., low tracheotomy; Z, hyoid bone; Sch, thyroid cartilage; R, cricoid; Th, thyroid body.

3. **Extirpation of the Larynx** (**Laryngectomy**) is always a serious operation, which is never undertaken except for malignant disease. According to the site of the tumour, the removal may be partial or complete; for a growth strictly limited to one side, extirpation of that half will suffice, and admirable results have followed such treatment, distinct speech remaining; but if the whole larynx is removed, although the patient is subsequently able to whisper, phonation is impossible without mechanical assistance, whilst if the disease has extended beyond the limits of the larynx, operative interference is very unsatisfactory.

Operation for Complete Extirpation.—A low tracheotomy should be performed, as a preliminary measure, and preferably a few days before; the trachea is plugged with a Hahn's tube or a Trendelenberg's air tampon at the commencement of the operation. An incision is made in the middle line of the neck from the hyoid bone to below the cricoid cartilage, at the upper end of which a transverse cut is made, extending as far as the sterno-mastoid muscle on either side. The soft parts are then stripped from the lateral borders of the thyroid cartilage with raspatories, the sterno-hyoid, sterno-thyroid, and thyro-hyoid muscles being divided at their insertions. Both the superior and inferior laryngeal vessels are tied and divided. Having thus freed the larynx anteriorly, the subsequent steps of the operation may be undertaken either from below upwards or from above downwards; the former proceeding is, to our minds, the better. The crico-tracheal membrane is divided, and the larynx drawn forwards, so as to enable the posterior attachments, *i.e.*, the connections of the constrictor muscles to the cricoid and thyroid cartilages, to be severed by scissors, the larynx being thus separated from the anterior pharyngeal wall, which must be left intact, if possible. The thyro-hyoid membrane and the base of the epiglottis are cut through, and the final steps of the operation consist in cleaning the superior cornua of the thyroid, and dividing the lateral thyro-hyoid ligaments. The operation is not particularly difficult or dangerous, provided that the surgeon keeps close to the larynx, and that the disease does not spread beyond its limits. Should unfortunately other structures, such as the base of the tongue, be found to be invaded by the growth, these steps must be modified so as to secure, if possible, complete removal of the disease. Finally, the transverse incision is sutured, but no stitches are inserted in the median wound, which is plugged, and allowed to heal by granulation. The upper end of the trachea should be secured to the skin at the lower angle of the wound, so as to prevent its retraction. The patient is fed *per rectum* for a few days, or by the passage of an œsophageal tube. At the end of a week the tracheotomy tube is removed from its original situation, and inserted into the upper end of the trachea, the lower opening being allowed to close. When the wound has healed sufficiently, an artificial larynx can be inserted, by means of which the patient is able to speak in a somewhat reedy monotone, whilst deglutition also becomes possible.

If the disease is limited to half of the larynx, the thyroid cartilage is cleft in the middle line, and the operation thus limited to the affected side.

4. **Laryngotomy** is an operation undertaken for the relief of dyspnœa, arising from some sudden obstruction to the respiration, and is thus to be looked on as an operation of urgency. It is called for in cases where the entrance to the larynx is obstructed by a foreign body, for spasm of the glottis, or for accumulations of blood in the neighbourhood of the larynx during an operation. It is readily performed by making a vertical incision over the situation of the crico-thyroid membrane, which is then divided transversely along the upper border of the cricoid cartilage, the sterno-hyoid muscles being, if necessary, drawn aside, and a tube inserted. Possibly the small crico-thyroid artery arising from the superior thyroid may require a ligature. In cases of great urgency, a simple transverse incision may be made with a penknife, and the larynx opened, the margins of the wound being held aside by a hairpin, or by the handle of a scalpel turned edgeways, or a toothpick will serve temporarily as a cannula. Whenever there is time to operate deliberately, a high tracheotomy is the better

practice, since a tube inserted through the crico-thyroid space gives rise to considerable irritation, and the voice may be subsequently impaired as a result of the contraction of the cicatrix. A special laryngotomy tube is required, the lumen of which is oval and flattened from above downwards, not circular.

In children, where there is but little space, the proceeding may be modified by division of the cricoid cartilage, and even of the first ring of the trachea, constituting what is known as cricotomy, or laryngo-tracheotomy (Fig. 270, IV.).

5. **Tracheotomy.**—The trachea usually consists of from sixteen to twenty rings, of which six or seven are situated above the sternum. The isthmus of the thyroid body usually covers the third and fourth rings, and the trachea may be opened either above or below it, or even sometimes behind, the isthmus being, if necessary, divided. Tracheotomy is required in a considerable variety of conditions in which there is obstruction to the respiration, *e.g.*, various forms of laryngitis, and especially that due to diphtheria; for stenosis, tumours, and some forms of paralysis of the larynx; for the removal of foreign bodies, either in the larynx, trachea, or one of the bronchi; or for compression of the larynx or trachea by external tumours, such as an enlarged thyroid body. It is also undertaken as a preliminary measure in operations on the mouth, tongue, pharynx, or larynx, in which there is considerable likelihood of asphyxia or secondary septic pneumonia, owing to the entrance of blood or septic discharges into the air-passages. As a general rule, the high operation (that is, above the isthmus of the thyroid body) is to be preferred, but under special circumstances it may be advisable to open the trachea lower down. The risk attaching to the high operation is considerably less than to the low, but the opening is made nearer to any disease which may exist in the larynx. For the removal of foreign bodies from the bronchi or trachea, the low operation should always be employed.

The *high* operation (Fig. 270, V.) is performed as follows: The patient is placed on the back, with a sandbag or pillow beneath the neck, so as to throw the head backwards and put the structures on the stretch, and with the shoulders somewhat raised. Anæsthesia may be induced by chloroform, but it is unnecessary, and indeed unwise, to push the anæsthetic, since it is only really needed for the division of the skin; where the dyspnœa is considerable, it is better to employ cocaine. The head is kept exactly in the middle line, and the surgeon feels for, and identifies, the cricoid cartilage. The incision should extend from this structure downwards for about 1½ inches. The superficial fascia is divided, and the interval between the sterno-hyoid muscles made out, so as to enable them to be separated one from the other. The edges of the wound are drawn aside by blunt hooks, which should both be held by one assistant, so as to make equable traction.

The isthmus of the thyroid body may now be seen, and, if projecting unduly upwards, should be pushed down after the fascia along its upper border has been transversely incised. The trachea is next clearly exposed by using the handle of a scalpel and dissecting forceps, and should be fixed and steadied by inserting a sharp hook into the lower border of the cricoid cartilage. The wound is freed from blood as far as possible, and the trachea opened by inserting the point of the scalpel and dividing two of the rings from below upwards. A deep inspiration is usually taken at once, followed by a severe fit of coughing, and if the operation is undertaken for diphtheria the surgeon must be careful not to let any membrane which may then be expelled enter his eyes, nose, or mouth. The insertion of the tube is in many cases easy, in others a matter of some difficulty; a good deal depends upon the age of the patient, the urgency of the symptoms, and the depth from the surface at which the trachea lies. Anything which suffices to separate the lips of the tracheal incision, *e.g.*, the handle of a scalpel introduced and turned, a couple of hooks, or dressing forceps, will form an efficient guide for this purpose. The breathing soon becomes quiet and regular, and the tube is fixed in position by tapes passed through lateral openings in the face-plate, and tied round the neck. All the dressing needed for the wound is to place a few layers of gauze about the tube beneath the plate.

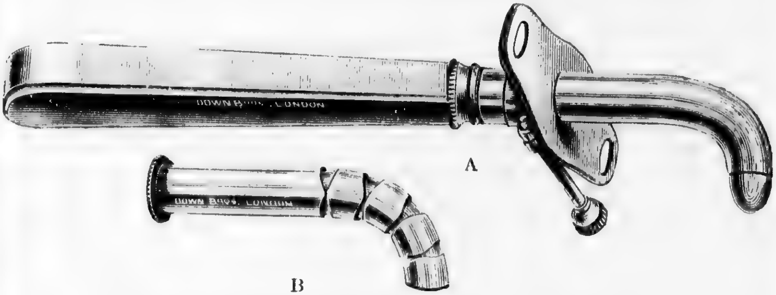

FIG. 271.—DURHAM'S TRACHEOTOMY-TUBE. (DOWN BROTHERS.)

A, Outer tube with introducer; B, lobster-tailed inner tube.

Low tracheotomy (Fig. 270, VI.) is performed in almost precisely the same way, except that the incision extends farther downwards, even reaching to the episternal notch, although the deeper part of the wound should never pass beyond a finger's breadth above the sternum, for fear of opening that portion of the cervical fascia, which is prolonged downwards to the pericardium, or of wounding the left innominate vein. The superficial layers of fascia are divided, and the sterno-hyoid and thyroid muscles drawn to either side by retractors. The inferior thyroid veins then come into view, and may give considerable trouble if they are distended with blood, as is so frequently the case in patients suffering from dyspnœa. They must be held aside by hooks, or divided between ligatures, and the deep layer of fascia behind them incised so as to expose the trachea, which is cleared, fixed, and opened in the same way as described above.

Many different forms of *tracheotomy-tubes* have been used from time to time, but that most generally employed consists of a double cannula, the inner portion of which can be readily removed and cleansed; it should always be longer than the outer, in order to prevent any plug of mucus being left within the outer tube on removal of the inner. A face-plate, or some similar contrivance, is attached to the outer cannula, in order to fix and steady it. One of the best is that known as *Durham's lobster-tailed tracheotomy-tube* (Fig. 271 A and B); the rigid outer tube of this instrument is introduced by means of a flexible guide set on a handle, and passed within it. The guide is then withdrawn, and replaced by the inner flexible cannula (B). *Parker's tube* (Fig. 272) also has a handy introducer, and is perhaps of a better shape than most of the others, following more closely the direction of the trachea. The *bivalve tube* is another useful instrument; the outer sheath consists of two lateral portions, attached to a single face-plate, and these can be pressed together, and hence with care easily inserted through the incision in the trachea. The surgeon must see that both limbs enter the trachea, as trouble has arisen from one limb passing by the side of the tracheal opening, and thus the introduction of the inner tube is prevented. In cases of preliminary tracheotomy, undertaken to prevent the entrance of blood during operations, a *Hahn's tube* may be used with advantage; in this the outer cannula is covered with a layer of compressed sponge which swells up from the absorption of moisture, and thus occludes the lumen of the trachea. *Trendelenberg's tampon*

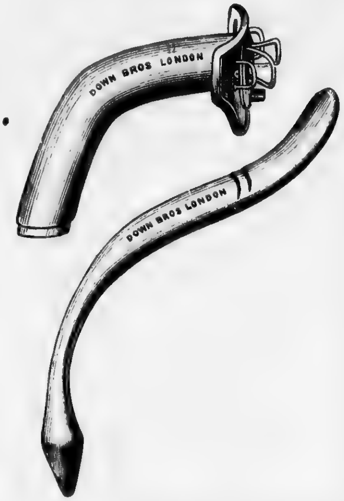

FIG. 272.—PARKER'S TRACHEOTOMY-TUBE AND INTRODUCER. (DOWN BROTHERS.)

is recommended by some surgeons for the same object; the outer tube is here ensheathed with a thin indiarubber casing, which can be distended with air at will.

Difficulties and Dangers of the Operation.—Although the above description might lead the student to suppose that tracheotomy is an easy operation, this is by no means always the case, partly owing to the fact that it frequently has to be undertaken in a hurry, with perhaps inefficient assistance, and in a bad light, and partly owing to the intense vascular engorgement of the structures met with. A cool head and a steady hand are in such cases of infinitely more value to the operator than the most perfect anatomical knowledge. The following are the chief conditions which may lead to mistakes and accidents:

(1) In semi-asphyxiated patients it is often advisable not to attempt the administration of any general anæsthetic, since complete *cessation of respiration* may be caused thereby, possibly from spasm of the glottis. In such the cutaneous incision may be made under the influence of some local anæsthetic, whilst for the deeper parts of the operation nothing is required.

(2) It is *not always easy to find the trachea*, especially in the necks of fat children, or where it is hidden by an unduly large thyroid isthmus, or possibly by the projection of the thymus gland into the neck. It is here most essential to remember the old adage, *In medio tutissimus ibis*, although occasionally the trachea may be displaced from the middle line by some external growth, and can then only be found by careful exploration with the finger.

(3) *Hæmorrhage* is generally troublesome. It is usually venous in character, arising either from the anterior jugular vein or from the inferior thyroid plexus. If possible, it should be controlled by forcipressure before opening the trachea; but this is not absolutely necessary in urgent cases, since it usually ceases as soon as easy respiration through the tube has been established. The presence of the left innominate vein in front of the trachea must not be forgotten, although it but rarely reaches above the sternum. In about 8 per cent. of all subjects an arterial twig (the *thyroidea ima*) courses upwards from the innominate artery along the trachea, to reach the isthmus of the thyroid body; if divided, it can be easily secured and tied. Should much blood be inspired, it may determine the occurrence of septic pneumonia at a later date.

(4) The possibility of the *entrance of air into veins* must not be overlooked, although it is an uncommon accident.

(5) Not unfrequently considerable mischief has been done by an *incautious use of the knife*, especially if the operator forgets to fix the trachea with a sharp hook before opening it. In a child the trachea is small; and if it is moving rapidly up and down, as happens in urgent dyspnœa, or if the child is restless, and not completely under the influence of an anæsthetic, the difficulty is

manifestly increased. Many accidents have happened from this cause, *e.g.*, wounds of the large veins or arteries of the neck, or even of the œsophagus or bodies of the vertebræ!

(6) As soon as the trachea is opened, a severe fit of *coughing* is induced, which is sometimes so prolonged as to interfere with the introduction of the tube. Under such circumstances the incision in the trachea may be opened up with a tracheal dilator, or by a pair of sinus forceps, and a few drops of cocaine swabbed over the mucous membrane.

(7) The *introduction of the tube* is a matter of no difficulty if the surgeon takes the precaution of not removing the hook until this is satisfactorily accomplished. Many mistakes have followed the non-observance of this rule; thus, the tube has missed the trachea altogether and passed into the fascial interspace in front, as also to one or other side; as before mentioned, the outer portion of a bivalve tube has often been passed with one limb within the trachea, and the other outside. A very dense diphtheritic membrane has also been a cause of difficulty, in that, although the tube has been really passed into the trachea, it has not penetrated the membrane, and thus has hindered rather than helped the breathing. In all cases of diphtheria the trachea should be freely opened, and the interior carefully examined by separating the lips of the incision before attempting to insert the tube. In order to prevent the downward passage of the membrane, some surgeons have recommended that the lower portion of the larynx should be carefully stuffed with antiseptic gauze above the tube.

After-Treatment.—The patient should be placed in bed, in a room kept at a uniformly warm temperature (75° F.), the air being moistened by the steam issuing from one or more bronchitis kettles, so as to make up for the absence of nasal and oral respiration. All draughts should be excluded by curtains, and nothing should be placed over the entrance to the tube, so that respiration may not be hindered, nor the expectoration of mucus, false membrane, etc. One of the most frequent sources of extension of diphtheria to the lungs, or of septic pneumonia, is the re-inspiration of septic material which has been coughed out on a portion of muslin or gauze, placed with excellent intentions over the mouth of the tube. A nurse should be in constant attendance on the patient, in order to wipe away any such material as it is expelled.

The inner portion of the tube should be removed by the nurse, and cleaned two or three times a day, any inspissated mucus upon it being readily removed by the use of a solution of bicarbonate of soda (20 grains to 1 ounce). The outer tube is also removed once a day for cleansing purposes, but only by the medical attendant. Should the respiration become impeded by a collection of mucus in the trachea, a fine feather may be passed down the tube in order to clear it, but *never in diphtheritic cases;* for such a contingency special suction-tubes have been devised.

Attempts have been made to clear the passages by applying the lips to the tube, and removing the obstruction by suction. Such is, however, quite unjustifiable, and several promising house-surgeons have in this way lost their lives.

The period for which the tracheotomy-tube is kept in position varies in different cases, but its removal should always be undertaken at as early a date as possible, for fear of leading to impairment of the voice. In order to prevent this, the inner cannula is made with a hole in the upper end, so that part of the air may pass through the larynx. If the patient can then breathe comfortably when the finger is placed over the entrance to the tube, its presence is no longer necessary.

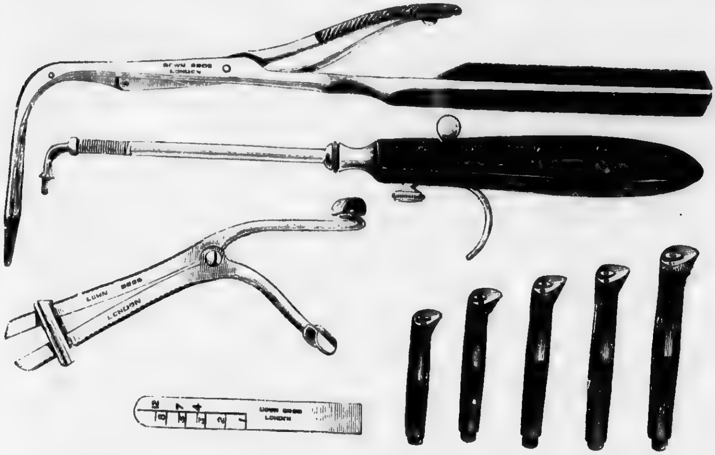

FIG. 273.—O'DWYER'S INTUBATION APPARATUS. (DOWN BROTHERS.)

The cannulæ are seen below on the right-hand side; a hinged inner tube passes throughout the length of each, and the upper end of this is screwed to the extremity of the introducer seen in the middle; when it has been inserted into the larynx, the trigger of the introducer is drawn, and by this means the inner tube is loosened and can be easily removed, leaving the cannula in position. To extract the tube, the rectangular forceps represented at the top is utilized; the point of the forceps is inserted into the top of the cannula, and then by opening the blades the cannula is fixed and can be withdrawn. A useful type of unilateral gag is also represented, and a small gauge to indicate the size of cannula required at different ages.

After-Complications of Tracheotomy.—(*a*) The tube has been known to give rise to ulceration of the trachea if it is not correctly shaped. Thus, if too much curved, it tends to irritate the anterior wall, and cases are known in which it has caused death from perforation of the left innominate vein. If insufficiently curved, the posterior wall may become affected, and the œsophagus laid open. In cases where a tracheotomy-tube has to be worn for a long time, it may be advisable to make use of the indiarubber tubes introduced by the late Mr. Morrant Baker, whilst Parker's tubes are also well borne.

(*b*) Various forms of septic trouble may affect the wound, leading to cellulitis, and even secondary hæmorrhage. This is especially dangerous in the low operation, since the inflammation may extend to the mediastinal tissues. In cases of diphtheria the wound may also become affected with the disease.

(*c*) Inflammation may arise in the trachea, bronchi, and lungs, resulting either from the entrance of cold, or unmoistened air, or from the inspiration of septic or diphtheritic material, and leading to bronchitis and septic broncho-pneumonia.

(*d*) Difficulty may be experienced in leaving off the tube, owing to the presence of granulations within the trachea obstructing its lumen, or to stenosis of the larynx from contractions or adhesions of the vocal cords, or even to spasm or rarely to paralysis of the abductor muscles. The trachea may also become kinked, and its calibre thus diminished by cicatricial union of the skin and mucous membrane. The diagnosis of the cause at work in any particular case can only be made by laryngoscopy, or careful examination of the wound and upper portion of the trachea. Granulations should be destroyed by caustics, stenosis of the larynx overcome by dilatation with an O'Dwyer's tube, whilst laryngeal paralysis must be treated by the use of electricity.

6. **Intubation of the Larynx** is a means of treating laryngeal obstruction which has been introduced in order to obviate the risk always present in tracheotomy. It consists in the passage through the mouth of a suitably curved tube into the larynx, by means of a specially contrived introducer. The best patterns to employ for the purpose are those known as O'Dwyer's tubes (Fig. 273). The lower end of the cannula is oval, and not circular, and passes between the cords into the larynx, whilst the upper enlarged end lies over the entrance. It has been used with considerable success in cases of œdema of the glottis and laryngeal stenosis, but is scarcely to be recommended for diphtheria, owing to the risk of carrying the false membrane down with it.

Surgical Affections of the Lungs.

Wounds of the Lungs result from violence applied to the chest, with or without fractures of the ribs, or in consequence of penetrating injuries.

Non-penetrating Wounds consist either of laceration or contusion.

Contusion of the lung usually follows some injury which is not necessarily associated with fracture of the ribs. The symptoms produced are severe pain in the side, with perhaps temporary shock, followed by slight hæmoptysis. Some traumatic inflammation follows, both of the lung and the pleura, as indicated by loss of resonance, and possibly friction sounds. The treatment consists in keeping the patient quiet in a warm room, at the same time carefully regulating the bodily functions. Possibly pain may be relieved by strapping the side of the chest.

Laceration of the lung is usually secondary to fracture of the ribs, especially when such is due to direct violence. The severity of the symptoms necessarily varies with the character and extent of the injury. The patient suffers from marked shock in severe cases, associated with pain in the side, and dyspnœa. Evidences of *hæmorrhage* soon follow, either in the form of hæmoptysis or hæmothorax. If the wound is a small one, the patient complains of an irritating cough, and brings up a good deal of blood-stained frothy mucus; but if the laceration is extensive, involving some of the larger pulmonary trunks, a quantity of pure blood may be ejected, even leading to death from syncope, or from asphyxia, owing to the blood filling the larger bronchial tubes. *Hæmothorax* may also be so excessive as to cause the patient's death from compression of the lung. It is evidenced by a gradually increasing area of dulness extending from below upwards, together with loss of breath sounds and vocal fremitus, coming on soon after the injury without signs of inflammation.

Owing to the laceration of the pulmonary vesicles, air tends to escape either into the pleural cavity, constituting the condition known as pneumothorax, or into the cellular tissue of the body, giving rise to surgical emphysema. *Pneumothorax* is always associated with more or less collapse of the lung, and is almost certain to give rise to considerable interference with the respiration, and possibly severe dyspnœa, or even orthopnœa. The air which finds its way into the pleura, having been filtered through the lungs, is free from organisms, and hence does not give rise to suppuration or putrefaction of the blood-clot which may be present, unless bronchitis or some other suppurative condition has existed previously. The physical signs of pneumothorax consist in absence of the breath-sounds and vocal fremitus; whilst on percussion a high-pitched tympanitic note is obtained, and on auscultation amphoric breathing, and possibly metallic tinkling. As soon as the wound in the lung commences to heal, the amphoric sounds disappear, the effused air is absorbed, and the lung gradually expands—a process which may take four or five days. If blood is also present in the thorax, a condition of hæmo-pneumothorax is produced, recognised by a splashing or succussion sound heard on shaking the patient. *Surgical Emphysema* almost always indicates a wound of both pulmonary and parietal layers of the pleura, which are slightly separated by air, constituting a localized pneumothorax. At each inspiration a fresh amount of air enters this cavity, and is expelled into the areolar tissues through the parietal wound at each expiration. It may extend for a considerable distance from the spot where it commences, even spreading over the whole body. It is of no serious significance, disappearing rapidly after the wound in the lung has commenced to heal, thus occluding the opened pulmonary alveoli. It is recognised by the parts becoming swollen and puffy, and giving a sensation of fine crackling crepitus when the hand is pressed over them. Occasionally emphysema may arise as an *interstitial* condition, when the parietal pleura has not been injured, the air escaping from the alveoli along the inter-alveolar connective tissue into the root of the lung, and then appearing first at the lower part of the neck.

Such are the ordinary phenomena observed in the early stages of a ruptured lung. The effects subsequently produced consist in a localized traumatic pleuro-pneumonia, associated with slight elevation of the temperature, possibly rusty sputum, and often severe dyspnœa. In the worst cases death may result from asphyxia.

Penetrating Wounds of the Lung are followed by very similar effects, modified, however, by the fact that the external wound in the chest wall allows of the exit of blood, arising either from an intercostal artery or from the wounded lung, whilst it also permits the entrance of septic organisms with the air into the pleural cavity, and thus may change the character of the resulting pleuro-pneumonia from a simple to an infective inflammation. Empyema is consequently a frequent sequela, whilst the inflammation of the lung may be of a spreading nature, possibly terminating in suppuration or gangrene. Surgical emphysema is also induced by air being sucked into the wound during inspiration, and failing to escape during expiration, owing to the lips of the wound falling together. This condition may ensue even when the lung itself has not been injured.

Treatment.—When the rupture of the lung is due to a subcutaneous injury, the patient should be kept quiet in a warm room, and the side strapped. The compression of the chest wall must sometimes be omitted in patients where the irregular ends of fractured ribs, broken by direct violence, are driven inwards, for fear of increasing the injury to the lung.

Persistent hæmoptysis must be treated by keeping the patient absolutely at rest, and allowing him to suck ice continually. Ergotin may be injected hypodermically, or a mixture of ergot, opium, and sulphuric acid administered; the opium is especially needed when great restlessness and irritability are present. Stimulants are necessarily contra-indicated, for fear of again starting the bleeding. Hæmothorax rarely calls for special treatment, since the blood soon clots and is readily absorbed; but occasionally it may be so abundant as to compress the lung and lead to dyspnœa, and under these circumstances it may be necessary to open up the pleural cavity and remove it. Such must never be undertaken until sufficient time has elapsed to allow of the wounded vessels being sealed by thrombosis. Decomposition of the blood in the pleural cavity occasionally happens even in non-penetrating injuries, the bacteria reaching it either from the blood or from the lacerated bronchi; the suppuration and fever thereby induced necessitate the opening and drainage of the pleural sac.

Simple pneumothorax seldom requires surgical treatment, since the imprisoned air is readily absorbed, and the lung quickly re-expands; but should it give rise to severe dyspnœa, it may be advisable to remove the air by aspiration.

Temporary dyspnœa may be overcome by the inhalation of oxygen; but when of a more decided character, and not due to any condition which can be removed, the one great essential is to diminish the blood-pressure, and thus decrease the amount of blood carried to the healthy lung, and enable it to cope with the work of blood-aëration. This may be accomplished by administering antimonial wine (10 to 15 minims every four or six hours) combined with full doses of liquor ammoniæ acetatis; but in urgent cases, where the patient is becoming cyanosed, and life is threatened by asphyxia, venesection must be resorted to. The blood is withdrawn from the arm rapidly and freely, and as it flows the dyspnœa disappears. This may be repeated once or twice before the full effect is obtained, and respiration becomes unembarrassed.

The treatment of *penetrating wounds of the thorax*, involving the lung, is always a matter of considerable difficulty. The skin around the opening is carefully purified and shaved, if necessary, and a limited exploration of the wound with a purified finger or probe is permissible, so as to determine whether portions of the clothing have been carried in, or if a rib has been comminuted; all such loose fragments should be removed, as also any penetrating foreign body, such as a bullet, if accessible. The greatest gentleness must, however, be employed, since it is easy to dislodge clots lying in the pulmonary lesion, and thereby re-start the bleeding. As a general rule, it is unnecessary to syringe out the parts with any antiseptic, as it is well known that gunshot wounds are often aseptic. Particularly does this hold good when the wound is deep, and it is possible that one of the main bronchi has been opened, since the lotion might readily be carried into the air-passages. The insertion of a drainage-tube is scarcely called for as a routine procedure, but it is advisable to lightly plug the wound with gauze.

The chief danger arises from the loss of blood, and, as already stated, this may come from division of an intercostal artery, or from the lung. If of *intercostal* origin, it should be treated as described at p. 232. *Pulmonary hæmorrhage* is, unfortunately, not so readily controlled; and much difference of opinion has been expressed as to the most satisfactory means to adopt in these cases. Probably the best method consists in keeping the patient absolutely at rest, and trusting to the application of cold to the side, and to the administration of hæmostatics, as indicated above for non-penetrating wounds. In bad cases the hæmorrhage may only cease when the patient is in a condition of profound collapse or syncope. At such a time infusion of a saline solution into a superficial vein or into the rectum may suffice to tide him over the period of danger, and lead to a successful result.

Two other plans of treating pulmonary hæmorrhage which have been recommended may be noted, viz., venesection from the systemic circulation so as to reduce blood-pressure, and thus obtain thrombosis; and plugging the wound in the parietes so as to cause the blood to accumulate in the pleural cavity, and thus by its pressure lead to a similar result. Neither of these methods commends itself to us as scientific, although both are occasionally successful, and possibly would be the only plans practicable in dealing with a large number of wounded, as after a battle. The latter of the two has an additional objection in that it is almost certain to be followed by suppuration and septic fever, necessitating the opening and washing out of the pleural cavity at a later date.

The question of opening the thorax by resecting a considerable portion of rib, so as to deal directly with the injured lung, has been raised of recent years, and several cases in which it has been undertaken have been recorded. Whether or not such practice is justifiable is a question that further experience can alone decide; at present all we can say is that a surgeon should be prepared to do this operation, although only resorting to it in exceptional circumstances.

The later treatment of these cases is much the same as for simple non-penetrating injuries. Should symptoms of septic pleurisy follow, the wound must be freely opened, a portion of rib being excised, if necessary, and the cavity washed out and drained, as for empyema.

Hernia of the Lung, or pneumocele, is a condition in which a portion of the lung protrudes through an opening in the thoracic parietes beneath the uninjured skin. It may occur suddenly, as the immediate consequence of a laceration of the intercostal muscles and pleura, or more gradually, being then due to the yielding of a cicatrix. It is most usually seen about the fifth intercostal space, but has been known to occur in the root of the neck, owing to a lesion in the dome of the pleura. It is exceedingly uncommon, being recognised by the appearance of a rounded swelling, increasing in size on coughing or making expiratory efforts, and possibly disappearing entirely on holding the breath. It imparts a crepitant feeling to the fingers when compressed, and on auscultation a loud vesicular murmur is heard. As a rule, no treatment is advisable in this condition beyond the application of a pad or truss.

A similar condition has been met with as a complication of an open wound, and is then termed a **Prolapse** of the lung. An attempt should always be made to return the protruded viscus, and to prevent its recurrence by suturing the aperture through which it has escaped. If left unreduced, it is very likely to become gangrenous from strangulation, and should then be removed by the application of a ligature, the wound being subsequently closed.

Empyema, or suppuration within the pleural cavity, results not only from traumatism, but also as a sequela of a simple pleurisy, or as a complication of various affections of the lungs. Again, a basal empyema is not an uncommon result of intra-abdominal suppuration. A description of the physical signs and symptoms belongs rather to the physician than to the surgeon. It will suffice to mention here that the affected side of the chest does not move on inspiration, whilst there may be some bulging of the intercostal spaces; on percussion the side is dull, except perhaps immediately below the clavicle, where tympanitic resonance may be elicited. On auscultation breath-sounds are absent, except in the vertebral groove, where bronchial breathing may be heard. The loss of vocal fremitus is also an important sign. A certain amount of fever and dyspnœa is usually present in cases of empyema, whilst the other thoracic viscera may be displaced. Left to itself, an empyema usually finds its way to the surface, and perhaps most commonly bursts through the fifth or sixth costal interspace, though sometimes through the second in front, owing to the perforating vessels being larger here than elsewhere. Occasionally localized empyemas are met with giving rise to similar effects, but on a smaller scale.

In the early stages the pleura is but little altered in structure, although a certain amount of lymph may be deposited on it; in old-standing chronic cases it becomes very dense and firm, owing to a development of fibro-cicatricial tissue, whilst the surface is converted into a layer of granulation tissue, similar to that found in all chronic abscesses. The lung collapses and retreats backwards towards the spine; at first its alveolar texture remains unaltered, and the early removal of the exudation enables it to re-expand, owing to atmospheric pressure. In chronic cases, however, there are two hindrances to this expansion, viz., the density of the thickened visceral pleura, which resists the atmospheric pressure, and the infiltration and sclerosis of the lung tissue itself. Under these circumstances, even when the exudation is entirely removed, the lung may remain collapsed, and Nature then attempts in several ways to remedy the mischief and close the pleural cavity: (*a*) The opposite lung undergoes expansion and hypertrophy, and together with the heart projects over to the opposite side; (*b*) the abdominal viscera and diaphragm are displaced upwards; (*c*) the chest wall falls in, and the spine becomes laterally curved, with its convexity to the sound side; and (*d*) there is an exuberant growth of granulation tissue from the surface of the pleura. In a certain proportion of cases these structural changes will suffice to determine a cure, but in others a cavity still remains, lined with thickened pyogenic membrane, and discharging pus or serum, according to whether or not sepsis is present. Under these circumstances extensive operative interference is necessary.

The **Diagnosis** of empyema is readily made by attention to the physical signs, and confirmation of such an opinion can be obtained by puncture with a hypodermic syringe. A medium-sized needle should always be employed for this purpose, and it is well to insert it along the top of a rib after drawing the skin up or down, so that on removal a valvular puncture results. The character of the organisms contained in the sample of pus thus withdrawn should, if possible, be ascertained, since it has been proved that the **Prognosis** depends much on this point. Thus, an empyema due to the presence of pneumococci, presumably following a pneumonia, runs a mild course, and is readily cured, even by aspiration alone; one due to the ordinary pyogenic cocci is more acute, and requires drainage with or without resection of a piece of rib. Again, the presence of tubercle bacilli renders the outlook much more serious, whilst the addition of septic organisms to any of the above aggravates the process and much impedes a cure. The chronicity or not of the affection is also a most important element in the prognosis, since the later the treatment commences, the denser are the adhesions which bind down the lung, and the less the chance of its re-expansion.

Treatment therefore should never be delayed; the earlier it is undertaken, the better the results.

Aspiration may be adopted in the first instance, but is generally to be regarded as of an exploratory nature, though a cure will occasionally follow when the empyema is of pneumonic origin. It is, however, sometimes of value in order to relieve for a time the pressure on the other lung and the resulting dyspnœa, and thus allow of the administration of an anæsthetic for the more serious subsequent operation.

Drainage of the pleural cavity through an external incision is the treatment almost invariably necessary, and the opening is best made either in the mid-axillary line or a little in front of it, through the fifth costal interspace. Whether a portion of rib need be removed or not is merely a question of mechanical convenience; if the drainage-tube can be efficiently retained between the ribs, well and good; but if, as in children, the space is narrow, then the costal resection is essential. An incision is made along the course of a rib about 1½ inches in length, and the periosteum stripped up from both the superficial and deep aspects of the bone, so as to enable a curved raspatory to be passed beneath it; at least 1 inch of the rib is then cut away with bone pliers. The parietal pleural is opened sufficiently to enable the finger to be introduced and the cavity explored. A large drainage-tube is then inserted, and the wound immediately covered, so as to prevent as much as possible the entrance of unfiltered air.

Formerly it was considered desirable to thoroughly wash out the pus; but it has now been demonstrated that such is unnecessary, and occasionally dangerous. Several cases of sudden death have been reported following this practice, probably originating from reflex irritation of the vagus. Where sepsis has been admitted, irrigation is often beneficial, but the following points must be attended to: (i.) The fluid employed must be unirritating, though sterile; (ii.) it must be at the temperature of the body, neither too hot nor too cold; (iii.) it must not be injected with such force as to impinge against the pleura or against the upper surface of the diaphragm; and (iv.) free exit must be given to it, so as to prevent tension from accumulation within the pleural cavity.

If such treatment is undertaken sufficiently early, the lung may be expected to expand, the discharge steadily diminishing, and the wound ultimately healing; but, as we have already explained, such does not always occur, and then a fistula persists leading into a cavity lined with a thick pyogenic membrane, discharging a variable amount of pus. The only means of obtaining a cure in these cases consists in removal of the rigid external wall, as by *Estlander's operation*, which is characterized by the excision of portions of ribs comprising the outer wall of the cavity. It is usually carried out through a vertical incision in the axillary line, the ribs being freed from their periosteal connections; the amount excised necessarily varies according to circumstances, and is in some cases very extensive. The fistulous track is enlarged, and the interior of the pleura carefully curetted and washed out, so as to remove all necrotic and degenerating tissue; the parietes are then allowed to fall back into contact, if possible, with the deeper layer, a drainage-tube is inserted, and the side firmly bandaged. A modification of this proceeding is known as *Schede's operation;* in this not only are the ribs removed, but also the intervening tissues, so that the subcutaneous or muscular structures in the flaps are laid down upon the prepared surface of the deeper layer of the pleura.

Necessarily, either of these methods of treatment is associated with considerable deformity, and also with a terrible weakening of the side, and plans have been suggested to obviate this by removing portions of a number of ribs before and behind, so as to leave the intervening segment free to collapse without totally destroying the osseous thoracic boundary. Another proceeding that has been recently introduced and practised with success is the stripping of the thickened pleura away from the collapsed lung, so as to enable it to expand once more (pulmonary decortication). Further experience is needed before any final opinion as to the merits of these operations can be given.

Various operative proceedings have been directed to the lung substance itself, of which, however, we can but suggest a few points.

Pneumotomy, or incision of the lung, has been undertaken for not a few pulmonary lesions, and the results obtained have been rather variable. 1. For *tubercular cavities* it is of little use. They are usually situated at the apex of the lung and drain well; the original disease is not removed; and the general health is frequently so impaired that the shock of the operation hastens the inevitably fatal issue. Hence it is only required in cavities located in the lower half of the lung, which drain badly, and the difficulty of diagnosing such conditions is considerable. 2. For *bronchiectases* pneumotomy, though *primâ facie* desirable, has given but little benefit, since it is uncommon for only one dilatation of the bronchus to exist. In suitable cases, however, where there is a good deal of fœtid secretion, which is with difficulty expelled, it may be useful. 3. In *gangrene* of the lung much benefit may be derived. 4. The same is true as regards *pulmonary abscess* following pneumonia. 5. In *hydatid* disease of the lung, incision and drainage have so considerably reduced the mortality, that this method of treatment should alone be adopted.

As to the *technique* of the operation, the first thing is to locate the mischief, and this is effected partly by a careful attention to the physical signs, partly by the use of an exploring needle or syringe. An incision is then made, and a portion of one or more ribs removed. If the lung is adherent to the thoracic walls, and shows no signs of retracting, the operation may be continued; but if no adhesions are present, it may be well to stuff the wound with gauze for a day or two, so as to determine their formation and thus shut off the pleural cavity. The lung itself may be punctured with sinus forceps introduced along an exploring needle, and then opened, or may be incised with a cautery. The abscess or other cavity is thus emptied of its secretion, and a drainage-tube inserted. As a general rule it is unwise to scrape or irrigate it, for fear of a communication existing with any of the larger bronchi.

Pneumectomy, or excision of a portion of the lung, has been attempted in a few cases of tubercular disease limited to the apex; it is, however, quite unjustifiable, since, if the affection is localized to the apex, it can often be cured by the usual medical means, whilst if it is more diffuse it cannot be extirpated. Primary malignant tumours of the lung, moreover, are usually central, and the diagnosis can rarely be made early enough to warrant an attempt at removal. The only conditions under which it is justifiable to excise portions of lung are: (*a*) when a hernial protrusion has become strangled through a small opening, and cannot be reduced; and (*b*) when malignant disease of a rib has invaded the superficial portion. In the former case, the base of the protrusion is transfixed and ligatured prior to cutting it away; in the latter, the disease is snipped away with scissors, and bleeding stayed by cautery, ligature, or plugging.

Wounds of the Heart.

Wounds of the Heart and great vessels are so usually fatal, either immediately or within a few hours, that it is unnecessary to discuss them here in any detail. If the patient does not die immediately, he suffers from intense shock and prostration, combined with a weak and turbulent action of the heart, great pain in the chest and dyspnœa, whilst the pulse is scarcely to be felt. Free hæmorrhage occurs if there is an external wound, whilst if the opening in the pericardium is small and valvular, the heart's action may be brought to a standstill by the pressure of the blood within. Should the patient survive, pericarditis generally supervenes, and is of a purulent type. As to *Treatment*, the great essential is to keep the individual absolutely quiet, and with the head low. The external wound should be purified, but during the stage of primary shock no attempt should be made to explore it, either by finger or probe, for fear of dislodging a clot. Later, when he has rallied, the question of exploration may be raised, and certainly one case (Capellen's) has been published in which the surgeon was by this means able to suture a wound in the ventricle; the patient died on the tenth day, but it is an encouraging record. Other cases are reported in which a wound of the heart has healed spontaneously, and the patient survived for many years.

Effusion into the Pericardium, whether serous or purulent, may occasionally require surgical treatment in order to relieve symptoms of cardiac failure, due to the pressure of the exudation. For serous pericarditis all that is needed is to aspirate the cavity. This is usually undertaken close to the left border of the sternum in the fifth interspace, or 1½ inches from the left margin of that bone through the fourth or fifth interspace, so as to avoid the internal mammary trunk, which courses down about a finger's breadth from the border.

For suppurative pericarditis an incision may be made in the same situation after removing the fourth or fifth costal cartilage, the cavity washed out, and even a drainage-tube inserted. Care must be taken to prevent infection of the mediastinal tissues, and this can sometimes be accomplished by stitching the pericardium to the skin prior to opening it.

Asphyxia.

Asphyxia, or **Apnœa**, is the term applied to indicate the condition arising from interference with or stoppage of the respiratory act. If this has not proceeded to any great extent it is termed **Dyspnœa;** when, however, the obstruction is so marked that the patient is obliged to maintain the upright sitting position, the term **Orthopnœa** is applied to it.

The **Causes** of asphyxia may be classified as follows:

1. Conditions arising from the presence of abnormal contents within the air-passages, *e.g.*, foreign bodies, blood-clot, or pus from the bursting of an abscess or aneurism; serum, as in œdema of the lung; mucus or muco-pus, as in bronchitis; the consolidated exudation in pneumonia; diphtheritic membrane; or irrespirable gases, *e.g.*, nitrogen, hydrogen, carbonic acid gas, etc., as in suffocation. Death by drowning usually arises from a similar cause, viz., the replacement of air by water in the respiratory passages.

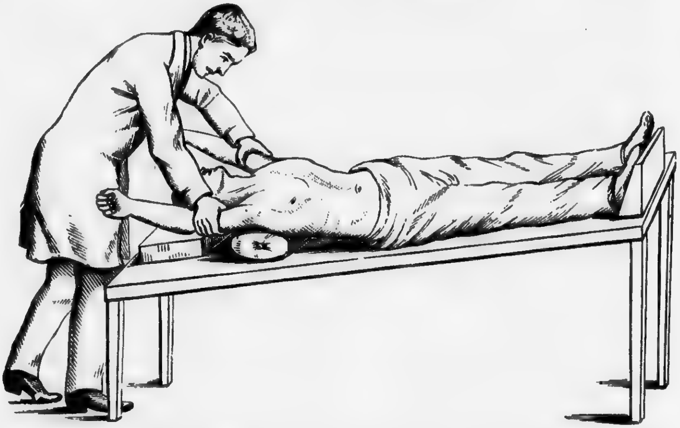

FIG. 274.—ARTIFICIAL RESPIRATION BY SYLVESTER'S METHOD (FIRST STAGE).

The arms are grasped just above the elbows, and raised well above the head so as to expand the thorax.

2. Causes arising in the walls of the air-passages, such as diminution of their lumen from inflammatory congestion, as in œdema of the glottis; cicatricial stenosis; the presence of new growths, or the displacement of parts, as in cut throat; or the falling back of the root of the tongue after partial excision of that organ.

3. Extrinsic causes, or those arising outside the air-passages, *e.g.*, in the *neck:* strangling, hanging, garrotting, etc.; the presence of tumours, such as goitres or aneurisms; a post-pharyngeal abscess or tumour, or, under exceptional circumstances, displacement backwards of the sternal end of the clavicle. Within the *thorax* gradually increasing obstruction to the respiration may be caused by the presence of tumours, aneurisms, or effusion into the pericardium or pleura.

4. Nervous causes, *e.g.*, paralysis or spasm of the larynx, and paralysis of the diaphragm, either from peripheral lesions, such as the pressure of aneurisms or tumours on the nerve trunks, or from central causes, such as a lesion in the

upper part of the spinal cord or medulla. It may also arise from paralysis of the respiratory centre, as from an overdose of chloroform.

5. In many forms of cardiac disease the lungs may become engorged with stagnant blood, leading gradually to dyspnœa, orthopnœa, and, finally, asphyxia, owing to the increasing difficulty in eliminating the excessive accumulation of carbonic acid.

The **Treatment** of the different conditions giving rise to asphyxia cannot be dealt with *in extenso* here. We can only indicate the general plan of treatment to be adopted. A rapid examination is at once made, to ascertain, if possible, the cause of the mischief, and whether its onset has been gradual or sudden. If it has been gradually developing, it is not uncommonly due to some thoracic condition which cannot be relieved; if, however, its onset has been sudden, and not due to any evident lesion, the neck and chest should be bared, and examined for any signs of traumatism, the mouth opened, the tongue drawn forwards, and the glottis examined with the finger to see that the passages are clear. The patient should, if necessary, be removed into fresh air, and artificial respiration at once commenced. Breathing can sometimes be excited by alternately dashing hot and cold water over the thorax, whilst electric stimulation of the phrenic nerve may also be undertaken, one electrode being placed over the neck, and the other on the hypogastrium. The administration of oxygen instead of air is useful during the earlier stages, whilst if the condition is due to cardiac disease with distension of the right side of the heart, venesection holds out the best hope of relief. Obstruction within the larynx needs tracheotomy or intubation, as also other conditions associated with pressure on the trachea.

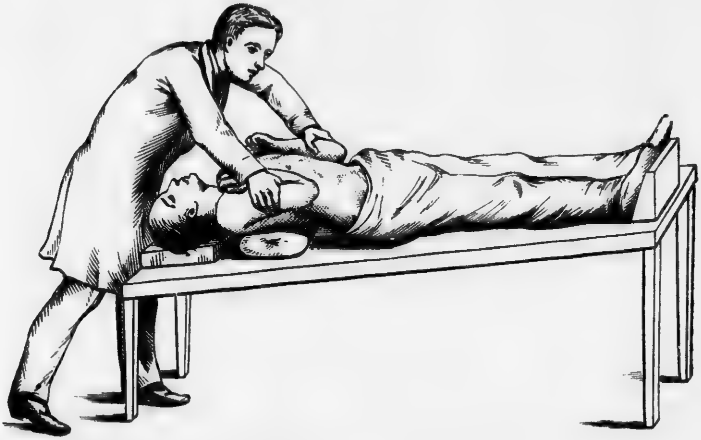

FIG. 275.—SYLVESTER'S METHOD OF ARTIFICIAL RESPIRATION (SECOND STAGE).

The arms are brought down to the side, and pressed firmly inwards against the thoracic parietes so as to expel the air. These two stages are alternately repeated about fifteen times in the minute.

In cases of threatened death from drowning, the first care must be directed to clearing the air-passages and mouth of water, weeds, etc., by rapid inversion, drawing the tongue well forwards, and swabbing out the pharynx; or the patient is turned on his face, with a firm pillow, or coat rolled up, placed beneath the thorax; and the chest is compressed so as to help in the evacuation of the water, which runs out of the mouth. Artificial respiration can then be commenced.

Artificial Respiration is required in a variety of surgical conditions, and is best undertaken by what is known as Sylvester's method. In this the patient lies on his back, with a pillow beneath the shoulders, the mouth opened, and the tongue drawn forwards. The arms are then grasped just above the elbows and drawn upwards above the patient's head, so as to expand the chest through the action of the great pectoral muscles. This position is maintained for about two seconds, and then the arms are lowered to the side, and pressed firmly against the ribs, so as to determine a forcible expiratory act. At the end of about two seconds more the arms are again elevated, and the same cycle again passed through. This should be repeated about fifteen times a minute, and the operator must be careful not to use too great violence, or to unnecessarily hurry over it, as harm rather than good thereby results.

Another less scientific method consists in alternately compressing the lower part of the thorax and abdomen with the hands, so as to drive out a certain amount of air, and then by suddenly relieving the pressure the elastic expansion of the chest walls draws in a fresh supply.

CHAPTER XXVIII.

DISEASES OF THE BREAST.

Congenital Malformations of the breast are much more common than is usually thought. One or more accessory breasts or nipples are found either below the normal one or just above it, but sometimes they have been found in the axilla, on the outer side of the thigh, or other curious situations. They are usually of a most rudimentary nature, but in a few cases they have secreted milk. The existence of these structures probably explains the occasional onset of cancer in unusual sites, as, for instance, when it originates in the axilla. Very rarely the breasts are entirely absent.

Affections of the Nipple.

Various inflammatory conditions are met with, most usually associated with lactation—*e.g.*, cracked nipples or eczema.

Fissures of the Nipple (cracked nipples) seldom occur apart from lactation, and may usually be traced to a want of care and cleanliness on the part of the mother, associated with a tender condition of the skin, which might have been prevented by bathing the parts during the later weeks of pregnancy with spirit, so as to harden them. The actual lesion is generally brought about by leaving the nipples wet after nursing. The superficial layers of epithelium become macerated, and are easily rubbed off, thus exposing the more delicate and sensitive deeper parts, which are irritated and inflamed by the repeated acts of suction. As a result, nursing becomes exceedingly painful, and if persisted in, the wound may become infected, the inflammation spreading to the breast substance along the ducts or lymphatics, or running up superficial to the breast along the lymphatics to the axillary glands.

Treatment.—One of the great essentials in order to prevent the occurrence of cracks is to bathe the nipples with some dilute antiseptic, such as boric lotion, immediately after nursing, and then to dry them thoroughly. If at all tender, a little powdered boric acid and starch should be dusted over them in the intervals. When a fissure has formed, it should be dressed with cooling or antiseptic lotions—*e.g.*, lotio plumbi, or lotio acidi borici. Sometimes more stimulating applications are required, such as a solution of sulphate of copper, or even of nitrate of silver. It is also recommended to paint them over with equal parts of glycerine and sulphurous acid.

Eczema of the Nipple may be simple, needing nothing but ordinary treatment, or it may take on special characteristics, being known as **Paget's Disease**, and is then supposed to be due to the presence and action of psorosperms (p. 22). It presents an excoriated, red, smooth surface, discharging an abundant yellowish viscid fluid, and may occasionally spread widely beyond the areola. It is almost invariably a precursor of cancer, and, indeed, some authorities maintain that from the first the disease is malignant, and not eczematous, in nature. The cancerous tumour is usually located beneath the nipple, and not unfrequently is similar to a duct cancer in its characters. No local treatment is of any avail, but the case must be carefully watched, and, on the appearance of any suspicious signs, the breast and axillary glands should be removed.

Abscess of the Areola is not uncommon in young girls about the age of puberty, arising in the sebaceous follicles, and requiring no special notice.

Chancre of the Nipple is rarely seen in the mothers of syphilitic children (Colles's law, Chapter XXXVIII.), but much more commonly in wet nurses.

Primary Tumours of the Nipple are met with as papillomata, sebaceous cysts, and occasionally epithelioma.

Inflammatory Affections of the Breast.

Acute Mastitis is naturally most often met with in *puerperal* women, owing to the sudden establishment of function in the breast after the birth of a child, and to the maintained activity necessitated during lactation. It results most commonly from a sore or cracked nipple, through which pyogenic organisms find their way into the breast substance, either along the lymphatics or the gland ducts. In the former case the inflammation is mainly interstitial in character, the pus diffusing itself widely between the lobules; in the latter the pus forms primarily within the alveoli of the glandular substance, but subsequently spreads beyond it. Simple obstruction to one or more of the ducts from inflammation of the nipple, without any external wound, also determines inflammation, which is frequently not suppurative in character. In *non-puerperal* women acute mastitis may result from injury, or may be pyæmic in origin. Occasionally a metastatic inflammation of the breast occurs after the disappearance of the parotid swelling in mumps; whilst in girls about the age of puberty a subacute inflammation, involving both the breast and areola, and even terminating in suppuration, has been observed. In newly-born infants a similar inflammation, occasionally running on to suppuration, has been seen, possibly resulting from an infection of the gland ducts during birth with cocci from the maternal passages. A slight enlargement, with congestion of the breasts, often occurs after birth, and may be due to, or is certainly aggravated by, the foolish habit followed by ignorant midwives of pulling or forcibly squeezing them in order 'to break the nipple-strings.'

Signs and Symptoms.—An inflamed breast is characterized by the organ becoming swollen, acutely painful, and tender. The gland lobules are felt to be enlarged and indurated, whilst if lactation is progressing, the secretion is to some extent impaired ; but owing to the inability of the mother to allow the child to relieve the organ, on account of the pain produced thereby, considerable tension results from accumulation of milk. If suppuration follows, the skin over the breast becomes red and œdematous, and, according to the situation of the pus, three different forms of acute abscess of the breast are described: (*a*) *Supramammary abscess* is the term applied to a collection of pus in the subcutaneous tissue; it is not unfrequently quite unconnected with the organ, but may originate in the superficial lobules. It is strictly limited, and does not tend to burrow deeply, coming readily to the surface. (*b*) An *intramammary abscess* is that most commonly met with, the pus developing within, and distending the lobules, or infiltrating the cellular tissue around them; it is usually diffused widely throughout the organ, and may point at several spots. (*c*) A *submammary abscess* is one forming in the cellular tissue beneath the breast. It may spread from some of the deep lobules, but may also arise in connection with disease of some of the adjacent ribs or cartilages, or as a cellulitis. In these cases the breast is pushed forwards, and becomes prominent, floating, as it were, on a bed of pus. The abscess tends to point at the periphery of the organ, perhaps in several places, but most commonly at the lower and outer quadrant.

Inflammation of the breast usually occurs in women who are anæmic and debilitated. Even the simple forms are associated with some fever and malaise, and this becomes greatly exaggerated if suppuration ensues, owing partly to the severe pain thus induced, and partly to the absorption of toxines.

The **Treatment** of simple acute mastitis consists, in the first place, in supporting the inflamed gland by means of a sling or bandage, and in binding the arm to the side, so as to keep the pectoral muscle, on which it lies, at rest. Hot fomentations are then applied, and any tension due to retained secretion relieved by the breast-pump. The bowels are opened, and the patient placed on a light and nourishing diet, whilst stimulants and tonics, such as iron and quinine, may be judiciously administered. As soon as the acute stage is passed, friction with warm oil, and perhaps the inunction of a belladonna ointment, are advisable.

When suppuration is threatening, the breast may be poulticed until fluctuation is detected; but under no circumstances must the abscess be allowed to burst into the poultice, and thus become septic. If such a practice is permitted, chronic suppuration may ensue, and the breast may even become riddled with sinuses. The most rigid asepsis must be maintained, and as soon as pus is evidently present, an incision should be made to evacuate it. In the *supramammary* variety it matters little in which direction the cut is made, as the pus is always superficial to the breast tissue. In the true *intramammary abscess*, the incisions should radiate from the nipple. One or more may be needed, and these should be made with a free hand, so as to allow of the insertion of the finger, and the opening up of any pockets or lobules which are distended with matter. A drainage-tube is inserted for a time, and gradually shortened day by day, until its entire removal is permissible. With such treatment the best of results may be attained, and it is instructive to note how quickly the functions of the breast are restored, and how slight is the permanent injury inflicted on the parts. The *submammary abscess* is best opened towards the lower and outer side, but also at any spot where pus points.

If septic sinuses persist after an abscess has burst, their orifices should be enlarged, and their walls thoroughly scraped and disinfected; deep cavities should be efficiently drained and stuffed with gauze, so as to ensure the wounds healing by granulation.

Chronic Mastitis occurs in two forms—one, a localized affection of one segment of the breast (chronic lobar mastitis), the other involving the smaller lobules and interstitial tissue (chronic lobular or interstitial mastitis).

1. **Chronic Lobar Mastitis** is by no means unfrequent as a result of imperfect involution of the organs at the cessation of lactation, but may arise from blows or squeezes, and is often met with in young women; it may also follow a subacute or acute attack, which has not ended in suppuration. It is characterized by an enlargement of one or more lobes of the organ, which are usually tender, and often excessively painful, the pain being of a neuralgic character, and increased during menstruation. The condition is of comparatively little importance, but may give rise to a great deal of anxiety and worry. All that is necessary in the shape of **Treatment** is to support the part and keep the arm at rest in a sling, whilst an ointment containing belladonna, or a belladonna plaster, may be applied.

2. **Chronic Lobular** or **Interstitial Mastitis** is an affection of much interest, which occurs most frequently in women with small or atrophic breasts, who have passed, or are near to, the climacteric. It is, however, sometimes met with at an earlier age. **Pathologically**, it is characterized by a diffuse overgrowth and infiltration of the connective tissue, which becomes sclerosed and

thickened. This by its contraction constricts the gland ducts and lobules, and as a result cysts form within the latter, being due to an exudation from the hyperæmic gland of serous fluid, which is unable to find an exit owing to the pressure of the interstitial growth. Such are known as 'involution cysts,' and the fluid contained therein is usually clear and limpid, but may be brown and turbid, from admixture of blood; intracystic growths are not present. Sometimes in the earlier stages the acini are full of a thick cheesy material, which can be squeezed out in thread-like masses, and probably consists of inspissated secretion.

Clinical History.—The condition often passes unnoticed in its early stages, until a distinct tumour has formed, which is nodular and indurated to the touch, and often very painful. The breast may be slightly enlarged, and there is, perhaps, some retraction of the nipple, owing to contraction of the interstitial tissue; but this is by no means an essential feature. A slight serous discharge is sometimes noticed, but as a rule only in the later stages. The skin rarely becomes adherent to the swelling, whilst the lymphatic glands in the axilla may be slightly enlarged and tender owing to sympathetic irritation. On careful examination of the breast, the affection is rarely limited to one particular region, for although a distinct enlargement of one portion may be present, yet the whole organ feels more or less 'lumpy,' and not unfrequently the other breast participates in the same change. There may be but little pain, but this is sometimes one of the most marked features of the case; it is of a neuralgic type, and usually increased at the menstrual periods.

If left to run its course, the disease may remain much in the same condition for many years, and even in time disappear; but more frequently it slowly progresses, and then results in one of three conditions: (*a*) *General atrophy*, the breast becoming shrunken, hard, and nodular. (*b*) More frequently *general cystic disease* follows, a condition in which the organ becomes transformed into a number of cysts held together by dense connective tissue. (*c*) There is some question as to whether or not *cancer* is a sequela of this disease; but there is abundant evidence to prove that any continued source of irritation in an organ like the breast renders an individual with a cancerous tendency more liable to its development.

The **Diagnosis** is sometimes easy, but the condition often simulates somewhat closely a scirrhous tumour. The chief points of distinction, however, lie in the facts (i.) that the whole breast is more or less involved; (ii.) that the opposite organ is very often similarly affected; (iii.) that enlargement of the axillary glands is less common than in scirrhus, and even if enlarged they are not hard as in the latter disease; and (iv.) that the skin is usually free from the mass. Moreover, the tumour is never adherent to the pectoral fascia, nor is it of the stony hardness of a scirrhus; it is often more disseminated and less defined than a cancerous growth. In doubtful cases an exploratory incision, and microscopic examination of a portion of the tissue, can alone be depended on.

Treatment.—In the early stages friction with some sedative application may be used at the same time that the breast is supported, and freed from the irritation of badly-fitting stays. Firm and equable pressure, as by strapping, is also useful in some cases, whilst iodide of potassium may be given. If a definite tumour is present, and especially if the patient is anxious and worried about herself, it is better to remove the affected lobules; a breast which is extensively affected should be removed, especially when there is an hereditary tendency to malignant disease.

Localized or Encysted Chronic Abscess is usually associated with pregnancy, and is characterized by the formation of an indurated mass in the breast substance, which slowly softens, giving rise to a sense of fluctuation, although when the abscess walls are very thick, as is often the case, it may be exceedingly difficult to detect. Retraction of the nipple is not uncommonly present, and the axillary glands may be somewhat enlarged. The condition has frequently been mistaken for a tumour, but is recognised from it by its incorporation with the breast substance, by its lack of definition, and by the fact that on careful examination elasticity, or even deep fluctuation can be felt at its centre, which is almost always less resistant than its margin, whereas the opposite is the case with a tumour. In cases of doubt the insertion of a grooved needle or an exploratory incision will settle the diagnosis. Some few of these chronic abscesses of the breast are of a tubercular nature.

Treatment consists in opening the abscess cavity, scraping out its interior, disinfecting with pure carbolic acid, if tubercular, and draining or stuffing it.

Diffuse Tubercular Disease of the breast is very uncommon. Scattered nodules of caseous material are developed in the interacinous tissue, which break down into pus, and come to the surface at various spots. The breast may thus become riddled with sinuses discharging caseous pus. It may be associated with tubercular disease of the lungs, whilst a like affection may arise secondarily in the axillary glands; possibly in some cases the primary trouble lies in the glands, the breast being involved subsequently.

Treatment should be carried out, if possible, by incision, scraping, and purification of the cavities; if this fails, nothing remains but amputation of the breast.

Occasionally a *chronic tubercular submammary abscess* forms as a result of a similar affection of the ribs or costal cartilages. It forms slowly, pushing the breast forwards, and is readily recognised, although the causative lesion can only be ascertained by exploration. It must be opened thoroughly, and its wall scraped and disinfected, whilst attention is also directed towards the affected bone.

Syphilitic Diseases of the Breast.—As already pointed out, a primary sore may be met with on the nipple; secondary mucous tubercles, or condylomata, are found in a similar situation or beneath a pendulous breast, whilst superficial and deep gummata have in rare cases formed in the tertiary period of the disease.

Cysts of the Breast.

When the structure of the breast, its abundance of ducts and alveoli, and its complex lymphatic distribution are considered, it is not surprising that many different forms of cystic changes are associated therewith. The following are the more important:

1. **Acinous or Retention Cysts** arise, as the name suggests, from some obstruction to the ducts or lobules, whereby the secretion of the organ is unable to escape. They are met with most frequently in women during or after the puerperal period, a milk cyst, or *galactocele*, being then produced. It usually results from some compression of one or more of the ducts, connected with a sore nipple, and contains inspissated milk; it forms a rounded swelling, and is located near the nipple. The wall is lined with cuboidal or columnar epithelium, according to whether a portion of the lobule or the duct itself is implicated; if, however, it attains any great size, the epithelium may become flat and squamous. This is surrounded by a fibro-cellular layer, the thickness of which increases with the chronicity of the case. It is treated by laying the part open, removing the contents, and stuffing or draining the cavity.

Similar glandular cysts form, as already described, in the course of chonic interstitial mastitis, and are then known as *involution cysts;* in long-standing cases, general cystic disease of the breast may supervene. Retention cysts have also been described as resulting from irritation of the nipple, as, for instance, when a young non-pregnant woman puts a baby to her breast; the organ becomes enlarged, the epithelium proliferates, and a thin serous fluid is secreted, which does not entirely escape and by its distention of the lobules gives rise to what may be termed *irritation cysts.* They may in time undergo spontaneous absorption, but Erichsen describes a case of this nature in which the swelling did not disappear until the patient subsequently became pregnant.

Again, one frequently finds cystic dilatation of the ducts and lobules arising in connection with certain tumours of the breast, such as duct papilloma, duct cancer, or cysto-adenoma. In the latter cases hæmorrhage from the contained growth is often seen, giving rise to a blood-stained discharge from the nipple. A scirrhous growth also occasionally starts from the wall of an acinous cyst.

In most of these retention cysts, discharge from the nipple may occur on squeezing the organ.

2. **Interacinous Cysts** develop in the interstitial tissue of the breast.

(*a*) **Serous Cysts** originate, it is supposed, by a dilatation of lymph spaces. They may be uni- or multi-locular, perhaps more frequently the latter. They are lined by a smooth, shiny layer of endothelium, and contain serum, perhaps blood-stained, and in old-standing cases cholesterine; being separate from the gland-substance, they never give rise to a discharge from the nipple, and intracystic growths are unknown. They are usually surrounded by a wall of connective tissue, which may become exceedingly thick and dense. Occasionally, however, they form a projection under the skin, and if the walls remain thin, fluctuation, and even translucency, can be observed. Such a condition is sometimes badly termed a *hydrocele of the breast.*

The **Diagnosis** of a serous cyst, if the wall is thick, is often a matter of considerable difficulty, as it resembles in many ways a scirrhus. It is recognised, however, by the facts that the growth is incorporated with the breast substance, usually occurring near its under surface; that on careful examination an elastic resistance is transmitted to the fingers, quite distinct from the stony hardness of a scirrhus; that there is no retraction of the nipple, and no enlargement of the axillary glands, whilst, as a rule, the patient complains but little of pain, and cachexia is absent. The diagnosis in cases of doubt may be readily determined by inserting a grooved needle, or by an exploratory incision, which should be made of sufficient depth to ensure the thorough division of the mass, for fear that a small cyst surrounded by walls of fibrous tissue, half an inch, or even an inch, in thickness, should be mistaken for a solid tumour.

Treatment.—Although it may suffice to lay the cavity open and drain it, it is decidedly wiser to remove it completely.

(*b*) **True Hydatid Cysts** are occasionally met with, manifesting the general characteristics described at p. 170.

3. Cysts may also arise in connection with cancerous or sarcomatous tumours, from degeneration of tissue in the former case, and from hæmorrhage into the substance of the latter.

4. **Dermoid Cysts** are described; but it is a little doubtful whether old galactoceles have not been mistaken for them.

Tumours of the Breast.

In investigating any case of tumour of the breast, the surgeon must never arrive at a hasty conclusion, but only give an opinion as to its nature after a careful and detailed examination. Thus, the age and previous history of the patient should be considered, as also the family history. Simple tumours generally arise at an earlier date than the malignant, whilst the sarcomata usually appear earlier in life than the carcinomata. There can be little doubt, moreover, as to the occasional tendency of tumours to run in families. The length of time for which the swelling has been observed should be ascertained, and whether or not it varies in size at the menstrual periods. The general appearance of the patient should be noted, as also the fact whether or not pain, local or neuralgic, is complained of. It is not unusual for pain to be referred to that part of the shoulder supplied by the posterior division of the second intercostal nerve, the anterior branch of which goes to the breast. A careful inspection of the organ should then be made, comparing it with the opposite breast, so that any signs of asymmetry may be noted. Dimpling of the skin, projection of the tumour or of the whole gland, and the condition of the nipple, are the chief points to which attention should be directed. Examination of the tumour with the flat of the hand, accompanied by gentle pressure of the finger-tips, must then be undertaken; it is not enough to pick up the breast substance between the fingers, as thereby false impressions are obtained. The relation of the tumour to the gland, its shape, its consistency, whether fluctuating or not, and its mobility on superficial, deep and surrounding parts should all be investigated. The lymphatic glands in the axilla must be carefully examined, as also, in suspicious cases, the supraclavicular glands.

The different forms of tumour met with in the breast may be arranged into three groups: the adenomata, the sarcomata, and the cancers. A few other conditions have been observed, but are so rare that they need no special description, *e.g.*, lipoma, fibroma, chondroma, and osteoma.

Adenoid Tumours of the Breast.—Four different varieties of tumour are included in this group, viz., the adenoma, adeno-fibroma, the so-called adeno-sarcoma, and the cysto-adenoma. Each of these is characterized pathologically by the following conditions: (*a*) Spaces lined by cuboidal epithelium are present in all; they may be tubular or slit-like in nature, simulating normal gland tissue, or they may become distended and cystic. (*b*) The epithelium lining their walls is in one or more layers, but scarcely ever arranged so methodically or evenly as in the normal structure. It is always limited by the basement membrane, and has no tendency to extend beyond it. (*c*) The spaces usually contain fluid, more or less abundant according to the amount of dilatation present, and generally serous in character, though perhaps brown or reddish in colour from admixture with blood. (*d*) Not unfrequently intracystic growths are present, and in one form, the cysto-adenoma, these are a specially prominent feature of the case. (*e*) The alveolar spaces are surrounded by interstitial tissue, which may vary considerably in amount, and be either simple or complex in structure.

Pure Adenoma Mammæ is said to exist when the proportion of interstitial tissue to gland substance is similar to that which obtains elsewhere in the breast. It is very uncommon and requires no special notice, the clinical characters not differing from those of fibro-adenoma, and its pathological nature being only specifically recognised on microscopic examination.

Case in [illegible]
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Fibro-adenoma (or Adeno-fibroma) is the most common mammary tumour met with in young people before the age of thirty. It is often attributed to a blow or squeeze, and doubtless such accidents are responsible for many of them. It occurs as a more or less rounded or oval mass, which, if placed superficially, moves freely on the breast substance, and, indeed, may be described as floating in it. If situated deeply, it still appears freely moveable, but its definition is less evident. It is usually firm, and more or less elastic in consistency, of slow growth, whilst it may be either painless, or in anæmic and neurotic women exceedingly painful, the pain often increasing at the menstrual periods. There is no concurrent enlargement of the axillary glands, unless arising from other causes, and no retraction of the nipple, with which it is entirely unconnected, whilst the skin over it does not dimple. The general health is unimpaired unless the patient is suffering from an associated anæmia. On section after removal the tumour is of a greyish-white colour, becoming pink on exposure to the air. It is more or less foliated in texture, being compared by Virchow to the section of a cabbage; no juice can be obtained on scraping the cut surface with a scalpel, although on pressure some fluid of a thick glutinous or mucoid nature may be expressed. Microscopically, the tumour consists of imperfectly developed glandular elements, surrounded by a considerable amount of firm interstitial tissue, but ducts are never present. The tumour is distinctly encapsuled, except at the one spot, through which vessels enter, and at which it is connected with the neighbouring mammary tissue. It is stated that fibro-adenomata are occasionally converted into sarcomata, thus changing their type from simple to malignant; the evidence, however, as to this is not conclusive.

The **Diagnosis** is readily made if the above signs are considered. It differs from chronic insterstitial mastitis or a serous cyst by its exact definition and free mobility, whilst from malignant tumours it is distinguished by its slow rate of growth, and its freedom from adhesions either to the skin or to surrounding parts.

The **Treatment** consists in its removal, which is easily effected by cutting down upon the tumour in a direction radiating from the nipple, until the capsule is reached, when the mass is enucleated from its surroundings with a few touches of the knife.

Diffuse Hypertrophy of the breast (Fig. 276) is usually fibro-adenomatous in nature, and consists of a general enlargement of the organ, both gland substance and interstitial tissue participating in the process, and hence the breast becomes firm and indurated. It may be uni- or bi-lateral, perhaps more frequently the latter, and generally occurs in adolescents. The size varies considerably, but the breasts may become enormous, hanging down by their weight, and perhaps to such an extent as to rest on the knees of the patient when sitting. They are usually painless, although sometimes neuralgia is noticed. Functionally they are useless, as even if the patient becomes pregnant, secretion of milk but rarely occurs. The only treatment is amputation.

The so-called **Adeno-sarcoma** is very similar in type to the adenoma, differing from it mainly in the increased rate of growth, in its soft consistency, and in the fact that the interstitial tissue is of a more embryonic character, and, indeed, is often of a mucoid nature. It is really a soft, rapidly-growing fibro-adenoma, and usually occurs in women at a somewhat earlier period of life than sarcoma or cancer—viz., between the ages of twenty-five and thirty-five. It may consist from the first of a localized tumour, increasing rapidly in size, or it may possibly commence as a simple hard or chronic fibro-adenoma, which, after remaining passive for a time, takes on a more active development. It remains, however, throughout its course strictly encapsuled, and when large may lead to pressure atrophy of the true gland substance. It is soft and elastic in consistency, as a rule painless, and freely moveable on the surrounding breast tissue. The skin over it remains healthy, although distended and atrophic when the tumour is of large size; the nipple shows no sign of retraction; the axillary glands are not involved, and there is no systemic invasion. On removal the section is similar to that of a fibro-adenoma, but cysts are often present, as also areas of mucoid softening, somewhat resembling sago. It can be readily removed in its entirety, and does not tend to recur.

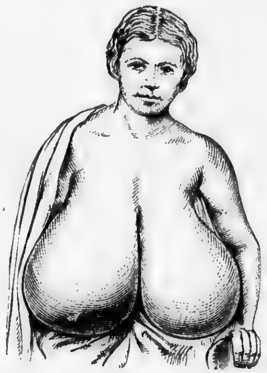

FIG. 276.—DIFFUSE HYPERTROPHY OF THE BREAST. (BRYANT'S 'SURGERY.')

Cysto-adenoma (*syn.:* **Cysto-sarcoma**, **Adenocele**, etc.) is a condition characterized by a marked development of intracystic growths, fibro-papillomatous in nature, within the dilated acini of a newly-formed mass of adenomatous tissue or within the smaller ducts (Fig. 277). It usually has a definite capsule, and then the normal gland tissue may be pressed aside, and perhaps atrophies. Several cysts are, as a rule, present, and may be of great size, the intracystic growths also varying in amount. These latter consist of branched processes something like a cauliflower in appearance, covered with cuboidal or columnar epithelium; they are exceedingly vascular, and hæmorrhage into the cavity of the cyst frequently occurs, as also a blood-stained discharge from the nipple. They are due to a proliferation of the interacinous tissue, which pushes the epithelial wall of the duct or acinus before it. The tumour produced is irregular in outline, owing to the projection of the cysts; it is usually painless, and unaccompanied by enlargement of the axillary glands; if of large size, blue veins are seen coursing over it. In the later stages the capsule becomes adherent to the integument, and, finally, owing to the pressure of the tumour, the skin may give way, allowing the growth to protrude. Such will be followed by the development of a fungating mass, which bleeds readily, and becomes extremely offensive. With care a probe can be passed between the intracystic portion of the growth and the thinned and stretched skin, which has merely given way, and is not incorporated with it; this fact is a ready means of distinguishing this condition from a fungating encephaloid cancer. The tumour is essentially benign in nature; it is never disseminated generally, and can be readily and completely removed, so that there is but little tendency to recur. In the early stages it is unnecessary to take away the whole breast if the tumour can be efficiently dealt with otherwise, but in the later stages the whole organ should be excised.

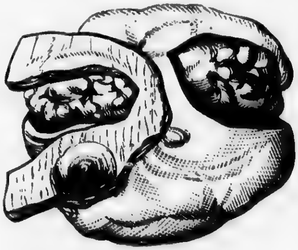

FIG. 277.—CYSTO-ADENOMA MAMMÆ.

The cauliflower-like papillomatous intracystic growths can be distinctly seen.

Somewhat similar in nature to the above is the condition known as a **duct papilloma**. This is characterized by the development of a soft polypoid papillomatous mass, generally of small size, in the interior of one of the terminal galactophorous ducts, which in consequence becomes dilated. A discharge of blood-stained serum results, and there is usually but little tumour to be felt. Occasionally, however, the nipple may be slightly pushed forwards and rendered prominent. It is very likely to determine the onset of a duct cancer, for which, indeed, it has been often mistaken. Amputation of the breast will in many cases be needed, although it may be feasible in some to deal with the tumour alone.

Sarcoma of the Breast is not a common disease. It originates in the connective tissue of the organ, being deeply placed in its substance, or perhaps more frequently developing in the outer and upper quadrant. It may be of two chief types: (*a*) The *round-celled* sarcoma forms a soft, somewhat elastic, swelling, which grows rapidly, and although possibly limited at first by a fibrous membrane, the capsule tends sooner or later to give way, allowing the growth to become diffused through the organ. Sometimes, however, the tumour remains encapsuled, pushing the gland substance aside. It sometimes gives rise to secondary growths in the axillary glands, or becomes disseminated throughout the body by means of the bloodvessels. Cysts often occur in its substance, resulting either from hæmorrhage or occasionally from the dilatation of an incorporated glandular alveolus; in the latter case the cyst will be lined with epithelium. Myxomatous changes are also not unfrequently observed, and in the more rapidly growing recurrent tumours the mass is often a true myxo-sarcoma. It usually occurs in women between the ages of thirty and forty, *i.e.*, somewhat earlier than scirrhus, whilst its rapid growth and absence of retraction of the nipple or dimpling of the skin are useful diagnostic features. Should pregnancy follow, it may increase in size at an alarming rate. In the infiltrating forms it is almost impossible to distinguish it from encephaloid cancer, except on microscopic examination. (*b*) A *spindle-celled* sarcoma, or fibro-sarcoma, is also met with, forming a rounded or oval tumour, more limited than the above, and growing somewhat less rapidly. It simulates somewhat closely an adenoma, but is in direct connection with the breast substance. The axillary glands are but rarely involved, and the sarcomatous nature is recognised by the microscope and by the great tendency of the growth to recur even after apparently complete removal; on account of this latter feature, the name of 'recurrent fibroid tumour' (Paget) was formerly applied to it. The recurrences generally take place at gradually diminishing intervals, and the tumour may then become softer and more vascular; occasionally the tendency to recur seems to wear itself out after the performance of several operations.

The **Treatment** of sarcoma mammæ consists in the removal of the entire organ at as early a date as possible, together with the axillary glands.

Cancer of the Breast.

No organ of the body, with the exception of the uterus, is more frequently the seat of cancer than the female breast; it also occurs in the male subject, but is about a hundred times less common than in the other sex.

Ætiology.—The breast is an organ subject to great changes in functional activity, richly supplied with blood, and closely associated by nervous connections with other organs of the body, especially the uterus. At the climacteric, its functions are at an end, and it usually undergoes a certain amount of degeneration. It can be readily understood, then, that in such an organ changes are very likely to ensue which may result in the formation of a cancerous tumour. Such is usually met with after the age of forty, although the disease may prove fatal at a much earlier date. It equally affects women who have borne children and nulliparæ, and the question whether or not the woman has nursed her children seems to have but little influence. The left breast is more often affected than the right. It is frequently attributed to some injury, such as a blow or squeeze; whilst there is little doubt that badly-fitting stays are responsible for a certain percentage of the cases. It not uncommonly follows eczema of the nipple, especially that variety known as Paget's eczema, which is supposed to be associated with the presence of psorosperms; chronic interstitial mastitis may also possibly be an occasional precursor of this affection. The question as to heredity is one exceedingly difficult to decide, and, although it may be a marked feature of some cases, it is somewhat doubtful whether, as a general rule, it has any considerable influence.

Two distinct types of cancer are met with in the breast—viz., acinous or glandular cancer (including scirrhus and encephaloid), and duct cancer. Colloid degeneration of either of the former varieties has been observed, but is very uncommon.

1. **Acinous Cancer** is the form almost invariably seen; the division into scirrhus and encephaloid is entirely artificial, depending on the greater or less amount of fibrous stroma present in any particular case, and is not *per se* a matter of great importance.

Scirrhus (Fig. 278) usually commences as a hard circumscribed mass, situated most commonly in the outer half of the organ. It is closely united to, if not absolutely incorporated with, the breast substance, and on careful digital examination its margin is not so accurately defined as at first appears. In the early stages it is entirely distinct from the skin, which moves freely over its surface; but as growth proceeds, the stroma contracts, and, by dragging on the suspensory ligaments passing from the mamma to the skin, the latter structure becomes more or less fixed, and hence, on attempting to move it upon the tumour, an appearance of dimpling results. At the same time, the whole breast is acted upon in a similar manner, so that the affected organ often seems to be smaller than the other; and, since the upper half of the gland is usually affected, the nipple may be drawn up so as to lie at a higher level than its fellow, as well as being retracted from the traction of the growth on the galactophorous ducts. The tumour itself is rarely one of great size, so long as it retains its scirrhous nature. A scirrhus is often extremely painful and tender; but not uncommonly the pain is intermittent, and of a neuralgic character, extending to the shoulder, and perhaps only elicited on manipulation. As the growth increases in size, it becomes adherent to the pectoral fascia, and may even infiltrate the underlying muscular substance, so that, on examination, it is found that, although moveable across the fibres of the muscle, the breast cannot be moved with them when the arm is extended and abducted.

The *lymphatic glands* in the axilla soon become enlarged, the disease rarely lasting many months without this complication. Those running with the long thoracic vessels under cover of the pectoralis major are first involved, and, as the case progresses, the remaining axillary and subscapular sets become similarly affected, and even after a time the supraclavicular. When the deeper part of the breast is attacked, the disease may spread to the mediastinal glands along the lymphatics, which accompany the nutrient vessels arising from the internal mammary trunk; and thus intrathoracic deposits develop, which even extend along the subpleural connective tissue, and affect the pleural cavity and lungs. In those cases where the primary growth is situated near the inner border of the breast, the free lymphatic anastomosis across the middle line allows of the transmission of the disease to the glands in the opposite axilla, and possibly a similar affection of the opposite breast may arise from this cause.

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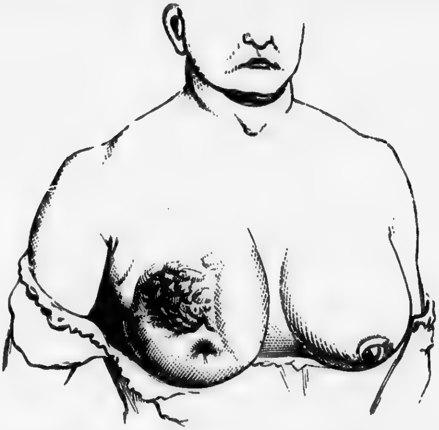


FIG. 278.—SCIRRHUS MAMMÆ INVOLVING THE SKIN, AND CAUSING RETRACTION OF THE NIPPLE.

The *skin* may be implicated in many ways. We have already mentioned the dimpling which is met with over the tumour in the early stages. As the case proceeds, the cancer extends along the suspensory bands of fascia outwards, so that the skin itself becomes invaded, feeling firm and brawny, and looking congested and purplish in colour, whilst a branny desquamation is usually present.

A crack or fissure at length forms, giving exit to a little serous discharge, which at first scabs over, but finally leaves an ulcerated surface, which slowly extends, and may attain considerable dimensions. A typical *scirrhous ulcer* is hollowed out and excavated; its surface, if kept clean, is covered with smooth granulations, discharging a considerable amount of sanious fluid, but if neglected, it becomes sloughy and offensive; it is surrounded by a projecting elevation of the tumour substance, forming a sort of rampart around it. Less commonly the disease becomes disseminated through the skin, giving rise to a series of dusky-red, button-like masses of cancer, surrounded by skin which is often unaffected; or the whole cutaneous surface of the organ may become infiltrated and thickened, constituting the condition known as cancer *en cuirasse*. In such cases the skin is dusky in colour, and so contracted and indurated that it is impossible to wrinkle it; the pores become enlarged, giving a 'pig-skin' appearance to the part, and may exude an abundant secretion which becomes inspissated on the surface into crusts or scabs, which are independent of any ulceration. This process often extends widely beyond the limits of the breast, invading the whole thoracic wall, and even running over the shoulder to the back of the head or neck. It is due to a diffuse extension of the disease along the cutaneous lymphatics.

In the later stages, the patient passes into a state of cachexia, becoming emaciated and exhausted. Ulcerated surfaces of considerable size may exist, and the tumour becomes fixed to the thoracic wall, even invading the ribs. The arm on the affected side is swollen and brawny, owing to the pressure of the enlarged glands on the main lymphatics and veins of the limb, constituting a condition of lymphatic or solid œdema. Secondary deposits also develop in the viscera, and may lead to various symptoms, according to the situations in which they are placed. Finally, death from exhaustion ends the scene.

Encephaloid Cancer occurs less frequently as a somewhat soft, rapidly-growing tumour, which quickly infiltrates the whole organ, and gives rise to secondary lymphatic and visceral affections at a much earlier date than scirrhus. It does not tend to cause retraction of the nipple or dimpling of the skin, the latter structure becoming distended, and with blue veins coursing under it. Later on the breast becomes enlarged and prominent, the skin is incorporated with the tumour, ulceration follows, and a foul fungating mass soon tends to sprout up through the opening.

Finally, in elderly women, a chronic form of cancer is met with, known as **Atrophic Scirrhus**, in which the disease may last for many years without much definite extension. Cases have been known to persist for fifteen or twenty years, the patient ultimately dying of some intercurrent malady, though, where the individual has lived long enough, dissemination has usually been observed. The special characters are due to the excessive contraction of the stroma, as a result of which the cellular elements become crushed and practically destroyed. The nipple is deeply retracted, and the tumour and breast substance in the most marked cases are scarcely discernible.

2. **Duct Cancer** is an exceedingly rare form of the disease. It is characterized by the development of one or more nodules of a malignant papillomatous nature within the dilated ducts, and usually situated not far from the nipple. These growths are covered with columnar epithelium, and may, indeed, be looked upon as forms of columnar cancer. They are exceedingly vascular, and a blood-stained discharge from the nipple is usual. These tumours always grow slowly, and do not attain any great size, but when situated near the skin give rise to a round dusky-red swelling. The nipple is not retracted, and lymphatic enlargement not constant. The diagnosis can only be established with certainty by microscopic examination after removal.

The **duration** of cancer varies considerably in the different forms. The encephaloid type runs a rapid course, and will probably destroy the patient's life in six to twelve months. Duct cancer is very slightly malignant, whilst atrophic scirrhus is similarly slow in growth, and in both death may be postponed for a considerable period, and is often due to some intercurrent malady. The infiltrating form of cancer *en cuirasse* is somewhat variable in its course, being sometimes tolerably rapid, and at others chronic; it cannot be cured by operation, on account of its early and extensive dissemination. A circumscribed scirrhous tumour is stated to end fatally, on an average, in between two and three years if no operative treatment is undertaken, whilst removal of the mass will probably add another year or eighteen months to the patient's life. These figures are, however, derived from statistics of operations performed before the general adoption of the more exact and extensive measures which are now usually undertaken, and it is likely that they considerably underestimate the benefits derived from such interference.

The **Pathological Anatomy** of cancer is discussed in Chapter VI.

The **Diagnosis** of scirrhus from *chronic interstitial mastitis* and *chronic abscess* or *cyst* has been already considered. From *tumours of the adenoid type* it is easily distinguished. The stony hardness of a scirrhus, its union with the breast substance, its limited mobility, the dimpling of the skin, retraction of the nipple, and enlargement of the axillary glands, are the chief local characteristics to be noted. Non-malignant tumours are more elastic to the touch, more moveable, and usually quite circumscribed in outline, whilst the skin, though expanded, does not become adherent; the nipple is rarely retracted, and the axillary glands remain of normal size. It is often impossible to distinguish a cancerous from a *sarcomatous tumour*, except on microscopic examination; a round-celled sarcoma closely resembles an encephaloid cancer, although it is usually more circumscribed—at any rate, in the early stages. The *fibro-sarcoma* may sometimes be mistaken for scirrhus, but it is more defined in outline, does not cause retraction of the nipple or dimpling of the skin, whilst lymphatic enlargement is not a constant accompaniment. A *cysto-adenoma* presents no difficulty in diagnosis if the skin is entire, and the cysts prominent; but when ulceration has taken place, and a fungating bleeding mass protrudes, it is not unlike the later stage of an encephaloid cancer or fungating round-celled sarcoma. It can be distinguished, however, by the fact that a probe can sometimes be passed under the skin for some distance into the cavity of the cyst, whilst lymphatic enlargement is rare.

Treatment.—This necessarily consists in the removal of the tumour by operation; but in order to give the patient as good a chance as possible of a permanent cure, the excision should also include the whole of the breast, the greater portion of the overlying integument, the subjacent pectoral fascia, possibly a part of the pectoral muscle, and the whole of the lymphatic and connective tissues of the axilla. A full description of the operation is given below, but we desire here to emphasize the fact that the proceeding must be very radical if the patient is to derive any real benefit from it. In the old days, only the more prominent portion of the breast was removed with the tumour, and consequently recurrence was so exceedingly common that if 5 or 10 per cent. of the patients were really cured, it was thought to be as much as any surgeon could reasonably expect. Since we have learnt more of the anatomy of the part, and of the pathogenesis of the disease, more extensive proceedings have been undertaken, with a gradual amelioration in the results, so that, at the commencement of 1896, Mr. Watson Cheyne was able to report 59 per cent. of his cases as free from recurrence at the end of three years. It was suggested by Volkmann that any case that remains free from recurrence for three years may be claimed as a cure, but this is generally considered too short a period on which to form such an assumption, since experience tells us that the disease often reappears at a much later date (even nine or ten years).

It has been proved that the breast is a much more extensive organ than was formerly supposed, and if merely the projecting portion is removed, many deep lobules are left, which may lead to recurrence. Moreover, it has been shown that the deeper lymphatics pass into the fascia covering the pectoralis major, and so to the axilla; hence, this structure should always be taken away, as well as a thin layer of the muscular fibres in certain cases. Again, lymphatics travel along the fibrous bands reaching from the breast tissue to the overlying skin, and thus this latter must never be dissected back from over the tumour. The nipple should under no circumstances be left behind, since all the interlobular lymphatics converge to a plexus around it, and reach the axilla by three or four main trunks. The axilla itself should be opened in every case, and entirely cleared of its lymphatic contents, since deposits in the glands are often found on microscopic examination, where no clinical evidence of their presence had been previously noted. It is also important to remove the breast and axillary tissues in one piece, so as to avoid division of the lymphatics and possible infection of the wound with their cancerous contents.

As to the cases in which operation should or should not be undertaken, the following facts must be noted: Cancer *en cuirasse* should never be touched, since it is impossible to eradicate the disease, owing to its wide dissemination through the cutaneous lymphatics. Atrophic scirrhus also is often excluded, since the prognosis is so favourable as to render operation unnecessary; if, however, the patient is fairly strong, and a complete operation is undertaken, there is no objection to it. Apart from these, all cases in which there is a reasonable prospect of eradicating the disease may be subjected to operation. The following grave conditions, however, require the most serious consideration: (i.) Where the supraclavicular glands are enlarged, it is hopeless to expect that the whole disease can be eliminated, even if the clavicle is divided, and the vessels and nerves cleaned as far as the posterior triangle. In some cases, however, where the presence of the tumour has a depressing mental effect upon the patient, or it is painful or beginning to ulcerate, it may be removed, although the patient or her friends should be warned that the disease is certain to terminate fatally. (ii.) If the tumour is adherent to the thoracic parietes, no operative interference is advisable. (iii.) Evidence of pressure on, or implication of, the axillary nerves also precludes such treatment; slight œdema of the arm due to pressure on the main vein need not deter the surgeon from proceeding, since the whole vein has been successfully excised; in such cases the collateral circulation had evidently been opened up previously. (iv.) Profound cachexia and evidence of visceral deposits also contra-indicate operation, except to give relief to the local pain. (v.) Extensive ulceration and fungation, and general diffusion of the tumour through the breast, are, as a rule, prohibitory signs. (vi.) Disease of both breasts, although rendering the prognosis more grave, is, *cæteris paribus*, no hindrance, since both organs have been removed successfully, even at one operation. Speaking generally, rapidly-growing tumours in vigorous patients are exceedingly unfavourable cases to deal with, whilst slow growth of the tumour, and definite limitation of its outline, are favourable signs.

Amputation of the Breast is an operation which is performed not only for the removal of cancerous or sarcomatous growths, but also for diffuse hypertrophy, for diffuse septic or tubercular disease when the organ is riddled with sinuses, and occasionally for interstitial mastitis. The proceeding is a very simple one in all but the malignant cases, which require separate mention. The incisions usually employed are semilunar, and placed obliquely, as in Fig. 279. The skin is dissected up on either side from the glandular tissue, and the organ freed from its attachments to the pectoral fascia; the axilla need not be opened.

Operation for Cancer.—The patient lies on the back, with the head directed towards the opposite side, and the arm raised well above it, so as to put the pectoralis on the stretch. The axilla should be previously shaved, and the skin carefully purified. The incisions employed vary with the size and position of the tumour; where it is located in the outer and upper quadrant, as is so commonly the case, incisions somewhat similar to those represented in Fig. 279 will do very well, although it is always necessary to include more skin between them. In other cases the incisions may be placed horizontally, extending backwards as far as the posterior axillary folds, and then the axilla is dealt with through a vertical incision running up along its anterior border. It is the usual custom to make the lower incision first, so that the view of the surgeon may not be interfered with by the blood trickling from the upper wound, but this is by no means essential or always convenient. The skin is dissected back on either side from the glandular substance, keeping well clear of breast tissue. The inner side is then dealt with first, the wound being carried down until the pectoral is exposed, and the gland, together with the deep fascia, dissected off the muscle from within outwards until its outer border is reached. Should the tumour be adherent to the fascia, it is wise to take away a considerable margin of muscular tissue with the growth. If the pectoral is actually invaded at any spot, these particular fibres should be isolated from those around them, and removed throughout the length of the muscle, since it has been shown that the interfibrillar lymphatics tend to travel along the course of the fibres. Should the muscle be extensively invaded, the whole of it—or, at any rate, the sternal portion—must be taken away; if the clavicular segment can be spared, the subsequent usefulness of

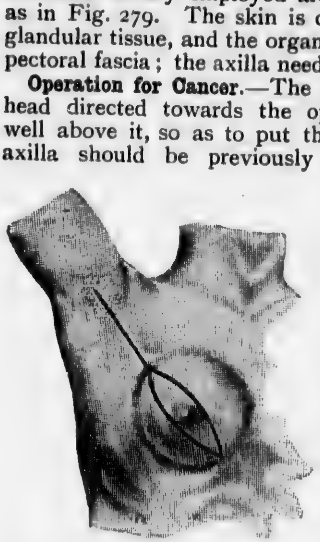


FIG. 279.—INCISIONS FOR REMOVING BREAST. (TILLMANNS.)

When cancer has to be dealt with, it is wise to make them considerably further apart.

the arm is much increased. During this stage of the operation, all bleeding-points are secured temporarily by Spencer-Wells' forceps. The breast, together with the fascia, and perhaps part of the muscle, is now lying turned outwards, merely connected to the trunk by its axillary attachments. The surgeon then carries on the dissection along the under surface of the pectoral muscles, opening up freely the axillary cavity, and if need be increasing the cutaneous incision for this purpose. The axillary vessels are first thoroughly cleaned, the vein often coming prominently into view. The apex of the space is then dealt with, all lymphoid tissue and fat being removed, and finally the inner and posterior walls are similarly treated, until when the dissection is complete nothing remains within the cavity but the main vessels and nerves; whenever possible, the subscapular branches should be spared. Having thus, it is hoped, eliminated the disease, all bleeding-points are ligatured, the wound is closed by a continuous suture, aided by one or two deep tension stitches, and a drainage-tube is usually inserted for a day or two; it may be placed with advantage through a special opening made in the posterior axillary wall. Where much skin has been removed, there will be some difficulty in bringing the edges of the incision together, but by judicious undercutting and sliding an open wound can usually be avoided. If, however, it cannot be closed, skin-grafting by Thiersch's method must be resorted to.

The immediate results of this operation are exceedingly satisfactory, the mortality being extremely slight, probably not 5 per cent. The final results necessarily vary with the period at which operation was undertaken, and with the care and skill of the surgeon. *Local recurrence after operation* is always due to incomplete removal of the growth, or to infection of the wound during the operation. The operator must ever keep in mind that although in a healthy organism the implantation of cancerous material has apparently but little, or no, effects, yet in a cancerous individual positive results are only too certainly obtained. The recurrence appears either in the neighbourhood of the cicatrix, the most usual situation, or in adjacent lymphatic glands. The progress is often slow, but occasionally the disease spreads more rapidly than if no operation had been undertaken. Another attempt should always be made to remove the growth, if such be feasible.

Recently a proposal has been made by Beatson of Edinburgh to deal with inoperable cases of cancer by oöphorectomy, combined with the administration of thyroid extract, and two or three cases of apparent recovery under this régime have been recorded. Certainly, if the patient is made to fully understand what is involved by such a proceeding, there can be no objection to trying it, since it holds out the only hope of prolonging life.

8/11/04

CHAPTER XXIX.

DISEASES OF THE SPINE.

Spina Bifida.

By **Spina Bifida** is meant a condition of imperfect development of some portion of the posterior aspect of the spine, with or without a similar affection of the spinal cord and membranes.

It must be remembered that the spinal cord is developed as a linear involution of the epiblast, the edges of this medullary groove growing up and uniting, so as to include a passage lined with epithelium, and subsequently known as the central canal. The cord is gradually separated from the overlying skin by the intrusion of mesoblastic elements, from which the vertebræ, together with the spinal muscles and ligaments, are developed. The ossification of each vertebra originates in three main centres —one for the body, one for each half of the neural canal, whilst epiphyses are developed as plates above and below the body, as also for the transverse and spinous processes.

The following are the chief forms of spina bifida:

1. A **Myelocele** results from non-closure of the primitive medullary groove. It is characterized by the appearance in the lumbo-sacral region of a raw surface, which consists of the spread-out structures of the spinal cord, at the upper part of which the central canal of the cord opens, discharging cerebro-spinal fluid. The condition is evidently incompatible with life, and the children, if they are not still-born, as is usually the case, do not live beyond a day or two.

2. A **Syringo-myelocele** arises from a distension of the central canal of the cord, the posterior portion of which usually remains adherent to the skin, from which it has never been separated, owing to defective development of the mesoblastic tissue. The spinal nerves travel round the walls of the cyst in order to find their way to the intervertebral foramina. Trophic phenomena are probably always a prominent feature of these cases.

3. A **Meningo-myelocele** is due to a development of fluid within the membranes which remain adherent to the skin, the spinal cord or nerves of the cauda equina passing down the posterior aspect

of the cavity as a strap, and the nerves traversing and perforating the sac to reach the intervertebral foramina.

4. A **Meningocele** is characterized by a protrusion of the membranes, containing cerebro-spinal fluid, through a defect in the posterior walls of the vertebræ, the spinal cord and nerves being in their normal position. This variety is uncommon.

Of these forms, the meningo-myelocele is that most frequently seen in living children, although, according to Bland Sutton, from whose book on tumours the above description is mainly derived, the first is really the most common.

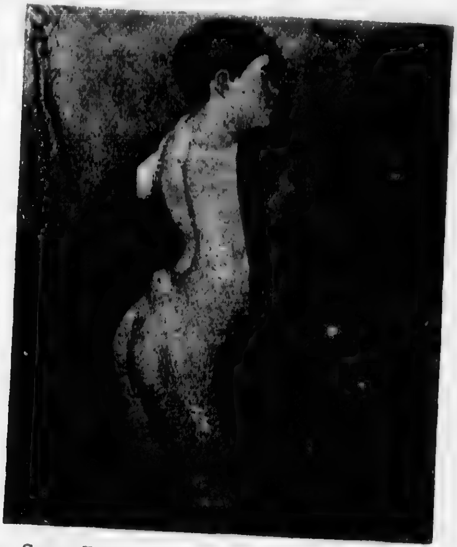


FIG. 280.—SPINA BIFIDA IN LAD AGED SIXTEEN, PROBABLY OF THE MENINGO-MYELOCELE TYPE. (FROM A PHOTOGRAPH.)

The swelling had not increased much in size since he was a child, but distinct trophic phenomena were being developed in the shape of talipes of both feet.

Clinical Characters.—A spina bifida is recognised by the appearance of a tumour in the middle line of the back (Fig. 280), most commonly involving the lower part of the spine; it may be covered by normal skin, but usually that over the apex is thin and translucent, and not uncommonly a certain amount of nævoid tissue is incorporated in it. On compressing the tumour, its size can be diminished, and in infants distension of the anterior fontanelle can be felt, showing that the sac is filled with cerebro-spinal fluid, and there is always a distinct impulse on coughing or crying.

The defect in the posterior portion of the vertebræ is very evident, the edges of the bones being felt at the margins of the tumour. Various other deformities may be associated with spina bifida, especially hydrocephalus and talipes, which are perhaps most common in cases of syringo-myelocele, whilst perforating ulcer, ankylosis of the terminal phalanges of the toes, and other trophic phenomena, are also seen.

The **Prognosis** of the case depends mainly on the thickness and character of the overlying skin; if it is thin, and the cord evidently adherent to it, as sometimes indicated by a cicatricial depression or dimple, the sac is very likely to give way, causing either death from sudden escape of cerebro-spinal fluid, or a fatal issue in a few days from septic meningitis. If the spina bifida is small, and covered with healthy skin and subcutaneous tissue, the patient may reach adult life. Occasionally a meningocele, with only a small aperture of communication with the spinal canal, may be cured spontaneously by the opening being gradually occluded.

Treatment.—The majority of these cases are best left alone, the tumour being perhaps guarded from injury by the application of a suitable cap. If the sac is gradually increasing in size, and threatening to give way, operative interference is absolutely necessary if life is to be saved. Acupuncture through the thinned integument, the cerebro-spinal fluid being allowed to drain away subsequently into an antiseptic dressing, or tapping through the healthier integument around the base, repeated several times, and followed by compression, may each lead to a cure in favourable cases. Statistics, however, go to prove that the best results are obtained by tapping, followed by the injection of Morton's fluid (℞: iodi, grs. x.; pot. iod., grs. xxx.; glycerini, ad ℥i.). A small quantity of the cerebro-spinal fluid is withdrawn, and then from half a drachm to a drachm of the iodine solution is introduced. It diffuses itself slowly, and tends to act locally, so that if the child is kept quiet, and only semi-recumbent, its effect will be limited to the sac of the spina bifida and its neighbourhood. In some cases persistent leakage may follow this treatment, and such is dealt with by means of a firm antiseptic compress; in many the injection needs to be repeated more than once.

Of late years treatment by operation has been coming more and more into vogue, thanks largely to the able advocacy of Mr. Mayo Robson, of Leeds. Naturally, it is chiefly applicable in the meningocele type, and infants or those suffering from trophic phenomena do not stand it well. An incision is made over the sac, either in the middle line if it is certain that the cord is not there, or to one side, if it is. The child should be kept with the head low when the sac is opened, so as to limit, as far as possible, the loss of cerebro-spinal fluid. In a meningocele, the protruding membranes are cut away, the wound in them is very carefully sutured, and the spinal muscles drawn together by deep stitches, so as to create an additional protective barrier, in addition to the skin and subcutaneous tissues. When the cord runs down the back of the sac, it is freed by an incision on either side, and if it cannot be separated from the skin, this whole strip is replaced in the vertebral canal, the membranes are closed over it, and finally the muscles and skin are united by rows of sutures. The results obtained by this means have been encouraging, and in suitable cases operation may be recommended with some prospect of success.

Spina Bifida Occulta is the term applied to a condition in which the posterior portion of the vertebræ is absent, but without any protrusion of the cord or its membranes. The overlying skin may be cicatricial in character, or a large growth of hair may arise from it; occasionally, a lipoma may develop in this situation, and by its downward growth compress the spinal cord, causing paraplegia. Unless such a condition is present, spina bifida occulta calls for no treatment, but an exploratory operation should always be undertaken when nervous phenomena supervene.

Congenital Sacral Tumours.

Other congenital conditions of the lower end of the spine are described as congenital sacral or coccygeal tumours. The majority of these arise from what is known to embryologists as the *neurenteric canal*. In early fœtal life it is supposed that the neural and alimentary canals are continuous, the passage of communication being known by the above name. Ordinarily, it entirely disappears after the union of the proctodeum with the intestine, but evidences of its existence are occasionally met with, either in the form of a cicatricial dimple adherent to the tip of the coccyx (*post-anal dimple*), or as one of the following conditions:

(i.) A *dermoid cyst*, containing the usual mixture of sebaceous material and epithelial cells, and often a tuft of hair; it develops in the space between the rectum and coccyx, and may either project posteriorly, below the coccyx, or open into the rectum; the tuft of hair may thus find its way out of the anus.

(ii.) A tumour of a glandular or adenomatous nature is occasionally found in the same region. It is characterized microscopically by the existence of alveoli, lined by cuboidal epithelium, held together by connective tissue; it may attain a large size, but is quite innocent. Such growths are termed by Mr. B. Sutton *thyroid-dermoids*.

Various other tumours are met with in infants in this region, and the same title of congenital sacral or coccygeal tumour has sometimes been applied to them:

(*a*) A *spina bifida* of the meningocele type, which may communicate with the subdural space, or may have been shut off by a natural process of cure.

(*b*) A *lipoma* may also form here, and in some cases has simulated by its shape a caudal appendage.

(*c*) A partially developed fœtus may be met with, enclosed within the subcutaneous tissues of the sacral region, and is known as a *teratoma*.

(*d*) *Sarcoma* and *cystic hygroma* have also been observed in this region.

The conditions are so exceedingly rare that it is unnecessary to enter into details of treatment, which is conducted according to the general principles.

Inflammatory Affections of the Spine.

Several distinct forms of inflammatory mischief are met in the spine, and must be described here, viz., acute osteo-myelitis of the vertebræ, tubercular disease (by far the most important on account of its great frequency), syphilitic disease, rheumatic spondylitis, and osteo-arthritis (or spondylitis deformans).

I. **Acute Osteo-myelitis** is an uncommon affection, which has only comparatively recently been recognised. It is due to the same causes as similar disease elsewhere, viz., infection with pyogenic organisms in an individual of low germicidal power. It is characterized by severe pain in a localized portion of the back, and fever; deformity is not a marked feature, since massive necrosis occurs and not a gradually destructive caries. Abscesses form early, and there is great danger of an extension of the inflammation to the spinal meninges leading to a fatal issue. The prognosis is extremely bad, owing to this latter complication, and the only treatment consists in early incisions to evacuate the pus. Sequestra can be removed from the back of vertebræ, but scarcely from the front, except in the lumbar region.

II. **Tubercular Disease of the Spine or Spinal Caries** (*Syn.:* **Pott's Disease, Angular Curvature**).—The above names are applied to a condition due to tubercular disease of the vertebræ, and originating almost invariably in their bodies; as a result these structures are more or less destroyed, as also the neighbouring intervertebral discs, leading to the so-called 'angular curvature' of the spine. As will be pointed out hereafter, the deformity, though occasionally angular in character, is by no means always of this nature, and hence the latter title is misleading, and should be replaced, if need be, by 'angular deformity.' The term 'Pott's disease' is derived from Percival Pott, who first accurately described it in 1779.

Ætiology.—The causes of tubercular disease of the spine are much the same as those of tubercular affections elsewhere, viz.: it affects an individual predisposed to the development of tubercular disease either by some inherited tendency, or by impairment of his general health, as from some preceding illness, or exposure to defective sanitary conditions. The actual deposit of tubercle is probably determined by some injury which, though slight, and perhaps not noticed at the time, is sufficient to cause some local diminution of vitality, thereby constituting a favourable nidus in which the *Bac. tuberculosis* can develop. It is most frequently met with in children, but may arise at any age, and equally in either sex. Sprains and strains of the vertebral column, or of the soft parts attached thereto, are the local lesions mainly responsible for it. Any part of the spinal column may be involved, but the lower dorsal is by far the commonest. The cervical region is rarely attacked, except in children, whilst in adults the dorsi-lumbar vertebræ are the favourite seat.

Pathological History.—The actual changes in the bones in Pott's disease are exactly similar in nature to those we have already described as occurring generally in cancellous bone (p. 532), and no special description need be given here. The disease usually starts in one of two places, either under the periosteum covering the anterior surface of the vertebræ (this most often in adults), or at the line of junction of the upper or lower plate-like epiphyses with the body, the usual situation in children. In the former case the subperiosteal tubercular deposit early extends to the subjacent bone, and spreads to neighbouring vertebræ, either along the under surface of the anterior common ligament, or through the intervertebral discs, which are disintegrated by the process. When it spreads along the anterior common ligament (Fig. 281), the disease may be very extensive, body after body being eroded, and the intervertebral discs suffering even more than the bones. In such a case the deformity produced is not strictly angular, but rather of a general kyphotic nature. Occasionally, however, the disease starts simultaneously in many foci, so that the bodies of several vertebræ become pitted and carious, without producing

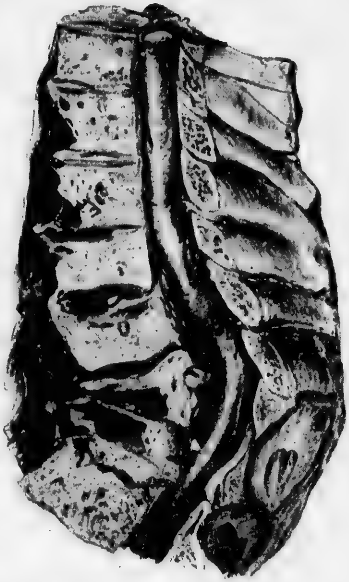


FIG. 281.—TUBERCULAR DISEASE OF SPINE, SHOWING DESTRUCTION OF BODIES OF THE VERTEBRÆ, AND ABSCESS FORMATION BENEATH THE ANTERIOR COMMON LIGAMENT. (MODIFIED FROM SPECIMEN IN COLLEGE OF SURGEONS' MUSEUM.)

general destruction. In other cases the process is limited to the bodies and intervertebral discs of two adjacent vertebræ, the periosteum being but little affected. This variety is, perhaps, most common in the lumbar region, where the bodies of the vertebræ are large and permit a limiting zone of sclerosed tissue to form; it is also not uncommon in this situation to find definite sequestra (Fig. 282).

The terms already described as characteristic of the different forms of caries may be applied to the varying conditions met with in this disease. Thus, when it runs its course without suppuration, *caries sicca* is said to be present; if pus forms, as is so frequently the case, *caries suppurativa;* and when sequestra occur, *caries necrotica.* Cure is effected by the bodies of the vertebræ falling together and becoming ankylosed, so that a deformed and immobile condition of the affected portion of the spine is often the best result that can be anticipated. The new bone thus formed is very dense and sclerosed in nature, and the synostosis also involves the spines and laminæ. Occasionally, the tubercular process extends backwards through the body of the bone so as to implicate the posterior common ligament, and paralytic symptoms may then arise from pressure on the cord.

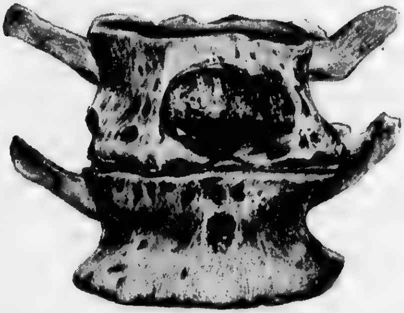


FIG. 282.—TUBERCULAR DISEASE OF TWO LUMBAR VERTEBRÆ, SHOWING SEQUESTRUM ON THE ANTERIOR ASPECT, AND LATERAL THICKENING PREVENTING ANGULAR DEFORMITY. (COLLEGE OF SURGEONS' MUSEUM.)

Rare cases have been described in which the disease mainly affected the sides of the vertebræ, as a result of which lateral deformity occurred; and still more uncommon are those in which the posterior portion of the neural arches is primarily involved.

The **Signs and Symptoms** produced by tubercular caries of the vertebræ vary considerably in different situations, but for practical purposes may be sufficiently described under the following five headings:

1. **Pain** is a constant and invariable accompaniment of the disease, although in the early stages it may not be specially prominent, being only elicited by careful examination. It is of two main types, the local and the referred. *Local pain* is more or less similar in character to that always experienced in disease of bones, although, owing to the cancellous nature of the osseous tissue involved, there is often but little tension, and hence may be slight. It can, however, be elicited in all cases, either by pressure or percussion over the spines, or perhaps more effectually by pressing upon the transverse processes, so as to induce rotation of the vertebral bodies one on another. Movements of the spine, bending or twisting, are similarly painful, whilst the same result can be brought about by jarring the spine, as by a blow on the head or nates. The old plan of testing for pain by means of a hot sponge applied over the back is comparatively useless in this disease. *Referred pain* is produced by pressure upon, or irritation of, the roots of the nerves as they emerge from the intervertebral foramina; consequently it is always noticed in those parts of the body which are supplied with sensation by the nerves issuing from the spinal canal in the diseased area. If the lumbar region is affected, the pain is referred down the legs; in the dorsi-lumbar region it may follow the last dorsal nerve, and be noticed in the lower part of the abdomen, or in the gluteal region; in the lower dorsal region pain is referred to the epigastrium, children who are unable to differentiate its precise nature complaining of 'belly-ache'; in the upper dorsal and lower cervical regions the pain extends into the arms, whilst in the upper cervical region neuralgia follows the course of the cutaneous branches of the cervical nerves. Thus, if the third and fourth cervical nerves are involved, pain is felt along the course of the descending sternal, clavicular and acromial branches; if the second and third are implicated, pain may be confined to the great auricular and occipital nerves; if the atlas and axis are affected, the neuralgic pain, if any, follows the occipital branches.

2. **Rigidity** of the spine is a constant accompaniment of Pott's disease. In the *early* stages it results from muscular spasm, the object being to fix and immobilize the painful part. If the lower portion of the spine is involved, the back is held stiff and straight, the patient abstaining from all movements which would bend or stretch it. Thus, in order to pick up an object from the floor, the knees and hips are flexed, and the patient gradually lets himself down with an absolutely rigid back into a sitting or squatting posture; the body is raised in a similar manner by resting the hands upon the thighs, the patient, as it were, climbing with extended arms up his own legs. In a child rigidity in the dorsi-lumbar region can be demonstrated by laying him on his face, grasping the ankles, and ascertaining the amount of movement of the spine at that region by lifting the legs from the table,

and also by moving them from side to side. In a healthy child the legs can be elevated, and the spine bent back in the dorsi-lumbar region, nearly to an angle of sixty degrees; whilst lateral mobility to the extent of thirty or forty degrees on either side of the median line is obtainable. When caries is present, neither of these movements can be obtained without including the thorax and dorsal spine. In cervical caries the patient steadies the head, and at the same time raises the shoulders by the help of the trapezius and sterno-mastoid muscles, whilst the chin is often supported by one hand, and the patient twists his whole body in order to look sideways.

In the *later* stages of the disease, when repair is taking place, or has occurred, rigidity of the spine is due to osseous ankylosis. After a cure has been established, compensatory movements of other portions of the spine mask, to a certain degree, the localized rigidity.

3. **Deformity**, the result of Nature's method of repair by means of osseous ankylosis, is necessarily produced in almost all instances, although in a few cases, taken in hand very early, it is possible that cure may be obtained without it. The amount and character of the deformity depend on a variety of circumstances, and perhaps most of all upon the number of vertebræ affected. Where only two bones are involved, a true angular deformity may result, the body of the upper vertebra being welded to that of the lower, so as to produce a wedge-like mass (Fig. 284, A), the surfaces of which are inclined to one another at an angle, compensatory curves of the spine elsewhere enabling the patient to assume the erect posture (Fig. 284, B). In the lumbar region, where the affection is often limited to a part of two vertebræ, there is usually little or no displacement, the disease being limited to the centres of the bones, so that the sides may escape altogether, and preserve the integrity of the spinal column; when a distinct projection of the spine is present, the portion of bone which appears most prominent is the spinous process of the lower of the vertebræ. When a large number of vertebræ are affected, as is common in the dorsal region, the curvature is never angular, but the whole region becomes bent forwards, and kyphotic in type, or even almost rectangular. Owing to the obliquity and length of the spinous processes of the dorsal vertebræ, the projection, even when only two bones are involved, is very considerable; in the latter case the spinous process of the upper vertebra, by becoming horizontal,

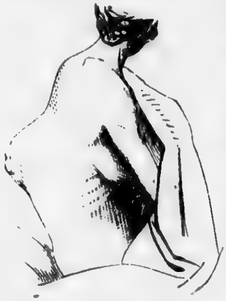


FIG. 283.—WELL-MARKED ANGULAR CURVATURE AS A RESULT OF POTT'S DISEASE.

is the more prominent. In the cervical region there is rarely much deformity, owing to the small size of the vertebræ, and to the stunted shape and deep position of the spinous processes; if, however, several bones are involved, the head may be carried forwards, together with the upper part of the spine.

Secondary changes in the shape of the thorax necessarily accompany the more advanced cases of caries in the dorsal region, the sternum becoming convex anteriorly so as to compensate for the diminished vertical measurement of the thorax, and the ribs crowded together to such an extent as to almost obliterate the intercostal spaces. The lower floating ribs may, however, retain their normal position, and thus a horizontal groove may be produced corresponding to the line of the tenth rib. In such cases the patient becomes much stunted in growth, and dwarfed, constituting the typical 'hunchback.'

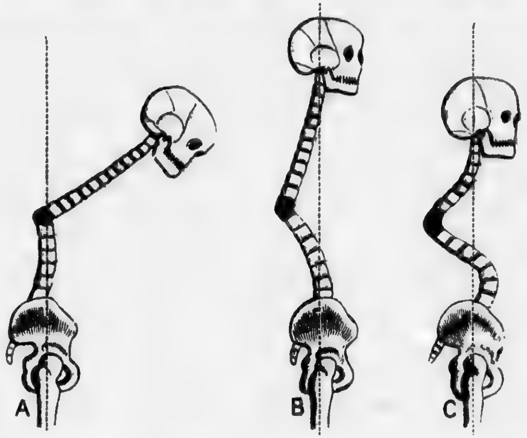


FIG. 284.—DIAGRAMS TO ILLUSTRATE DEFORMITIES IN SPINAL CURVATURE. (AFTER NOBLE SMITH.)

In A the result of the bodies falling together to form a wedge-shaped mass is seen in the anterior displacement of the upper half of the spine; in B the compensatory curves utilized by Nature to maintain the erect posture are indicated; in C the same process is seen in an exaggerated stage.

4. **Abscess** is the most serious symptom which arises in the course of spinal disease, for, owing to its deep origin, it often attains considerable dimensions before it is recognised or treated, whilst it is usually impossible to deal with the causative lesion in the bones, and if once the cavity is allowed to become septic, an exceedingly grave complication is introduced into the case, which may even determine a fatal issue. The pus collects originally on

the anterior aspect of the vertebræ, beneath the anterior common ligament (Fig. 281), which may be stripped from the bones for a considerable distance, owing to the tension within the abscess cavity. As a rule, however, it finds its way to the sides of the bodies after perforating the ligament, and thence extends in various directions, according to the portion of the spine involved.

I In the cervical region, a *chronic retropharyngeal abscess* is first formed; it pushes the posterior pharyngeal wall forwards, and may be detected from the mouth as an elastic fluctuating swelling, which, by its size, often leads to some difficulty in swallowing and breathing, whilst œdema of the glottis may be induced. Left to itself, various courses are open to it: 1. The abscess may burst and discharge into the pharynx, the cavity necessarily becoming septic, and the osseous lesion thus aggravated. 2. It may travel downwards behind the œsophagus into the posterior mediastinum, and thence extend in the same directions as abscesses in the dorsal region. 3. More often the pus finds its way to the side of the neck, being guided to the posterior triangle by the prevertebral fascia, behind which it is situated; less frequently it pierces this fascia, and presents in the anterior triangle. 4. In the lower part of the neck, it may spread under the clavicle into the axilla, being directed by the same fascia, which in this region passes downwards behind the subclavian trunks, and forms the posterior wall of the sheath of the axillary vessels.

II In the dorsal region, the abscess starts in the same way in front of the vertebræ, and may thence extend as follows: 1. Most frequently it passes backwards between the vertebral ends of the ribs to form a *dorsal abscess*, burrowing along the course of the posterior branches of the intercostal nerves and arteries, and forming a fluctuating swelling, 3 or 4 inches from the spinous processes, with an impulse on coughing. 2. It may extend between the ribs and the parietal pleura along the anterior branches of the intercostal vessels, coming to the surface at the spot where the lateral cutaneous branches are given off. Tubercular disease of the ribs, leading to caries or necrosis, or even a localized empyema, may be induced in such cases. 3. Very rarely the abscess may travel up to the neck, pointing behind the sternomastoid muscle. 4. Not uncommonly, however, it works its way downwards, passing under the ligamentum arcuatum internum of the diaphragm, thus entering the psoas sheath, and giving rise to a psoas abscess.

III In disease of the dorsi-lumbar or lumbar regions, either a lumbar or a psoas abscess may result. A *lumbar abscess* is due to the passage backwards of the pus along the posterior branches of the lumbar vessels and nerves to the outer border of the erector spinæ, and usually presents superficially in Petit's triangle—

i.e., between the adjacent borders of the latissimus dorsi and external oblique muscles. It there forms a tense fluctuating swelling, with an impulse on coughing. A *psoas abscess* lies within the sheath of the psoas muscle, the pus being usually superficial to the muscular fibres, some of which are probably destroyed. It passes downwards, giving rise to a fusiform enlargement, deeply placed in the back of the abdomen; at the brim of the pelvis, it usually burrows outwards under the fascia iliaca to form a tense rounded swelling in the iliac fossa (Fig. 9). It thence travels under Poupart's ligament, behind and external to the common femoral vessels, being constricted at this spot so as to form a narrow neck. It is then directed behind the common femoral vessels, which are often displaced inwards and forwards, along the tendon of the ilio-psoas, to the neighbourhood of the lesser trochanter, and, coming into relation with the internal circumflex artery, usually points at or near to the saphenous opening. It may, however, follow the different branches of the latter artery amongst the adductor muscles, forming a large swelling on the inner side of the thigh, expanding these structures, or it may even travel along its main trunk behind the neck of the femur to reach the surface behind the great trochanter. In other rare cases the pus has been known to extend down the leg, and has even reached the side of the tendo Achillis, where it has been evacuated. Occasionally, a psoas abscess finds its way down into the pelvis instead of passing under Poupart's ligament, and then points in the ischio-rectal fossa, or possibly burrows through the sacro-sciatic foramen.

The constitutional disturbance associated with the formation of these abscesses is usually but slight; perhaps there is a small rise of temperature, but if, as occasionally happens, ordinary pyogenic organisms find their way into the sac from within the body, this may become more marked. As they come to the surface, considerable pain may be experienced from the tension and irritation of the soft parts, and fever of a hectic type is induced.

5. **Paraplegia** is fortunately not a common result in tubercular caries of the spine, only occurring in the worst cases, or in those where treatment has been neglected. It is scarcely ever due to the acuteness of the curve, since the spinal cord is almost always efficiently protected by Nature. It has been known to result from a fracture of the spine, the integrity of which has been weakened by the inflammatory process, but is usually caused by an extension backwards of the disease, so that a nodule or button of tubercular material forms beneath the posterior common ligament, or pushes through it, compressing the cord against the laminæ, and actually invading the dura mater. It occasionally originates in the pressure induced by an abscess, which extends backwards into the spinal canal.

The effect produced on the cord varies with the rapidity and acuteness of the process. When the pressure is rapidly developed, a subacute myelitis results, but more frequently it is of a chronic or sclerosing type. The cord is then found to be constricted or indented by the tubercular mass, and perhaps considerably reduced in size; its texture is firmer than normal, and the colour grayish. The onset of symptoms may be suddenly induced by hæmorrhage or displacement of bone, but is more usually gradual. The dorsal region (about the eighth vertebra) is that most often involved, since there is plenty of space in the cervical region, and in the lumbar the cord has broken up into the cauda equina. Statistics seem to indicate that paraplegic phenomena occur in about one out of every thirteen cases.

The symptoms arising from pressure on the cord must be distinguished from those due to irritation of, or pressure on, the nerve roots. The latter causes neuralgic pain along the course of some particular nerve, possibly in the later stages associated with anæsthesia (*anæsthesia dolorosa*), or a limited motor weakness if the anterior roots are involved. In compression of the cord, motor phenomena are more evident than sensory, since the sensory track lies towards the centre of the cord, and so is more protected from injury. At first there is some dragging of the toes on walking, and loss of power in the legs, combined usually with neuralgia, weakness of the sphincters, and exaggeration of the reflexes. Later on the paralysis becomes complete, and, as degeneration of the cord follows, secondary contractions and rigidity may occur, and the reflexes may diminish. Absolute incontinence sometimes supervenes, the bladder emptying itself periodically and involuntarily, or the urine trickling away continually from either a full or empty viscus.

Special mention must be made here of a grave complication only occurring in the upper cervical region, and which may result in sudden death. Tubercular disease of the upper two vertebræ usually involves, even if it does not originate in, the large articulations on either side of the atlas; if these joints become disorganized, displacement may occur at any moment, and in this way the occiput slips forwards upon the atlas, and may lead to gradual or sudden compression of the cord and consequent death. The disease sometimes spreads to the body of the axis, and by this means the odontoid process becomes detached, or the transverse ligament gives way; in either case, the weight of the head carries the arch of the atlas forwards, and death ensues from compression of the medulla.

Course of the Case and Prognosis.—Left to itself, the disease always progresses more or less steadily, the bone lesion becoming gradually more marked, and abscesses tending to develop. If treated efficiently, and taken in hand early, repair by ankylosis may be confidently expected. Even when an abscess forms, prolonged rest may lead to its disappearance, the fluid part of the pus being absorbed, and the solid elements becoming inspissated and dry, forming a putty-like mass lying on the front of the vertebral column; this may subsequently break down, probably owing to infection with pyogenic cocci, constituting what is known as a *residual abscess*. Should, however, the abscess burst, or be opened, and allowed to become septic, symptoms of hectic fever and amyloid disease are almost certain to develop, and the patient sooner or later is exhausted by the discharge, and dies from asthenia. If dealt with judiciously, and sepsis is avoided, the abscesses may be cured, and if at the same time the spine is kept at rest, the lesion in the bones is able to consolidate. The onset of paraplegia, again, must not be looked on as rendering the case hopeless, since with prolonged rest the paralytic phenomena can entirely disappear. Septic cystitis and bedsores often arise as complications, and, if allowed to progress, cause the death of the patient. Occasionally, as a result of the implication of the spinal canal, diffuse meningitis follows, leading to a rapidly fatal termination. As in tubercular disease elsewhere, the patient also runs the risk of acute miliary tuberculosis, whilst other organs, *e.g.*, the lungs, brain, or kidney, may become affected. In spite of these possibilities, however, the prognosis is good as regards life in cases free from complications, and where suitable treatment has been adopted.

The **Diagnosis** of spinal caries is never a matter of difficulty when the characteristic deformity exists, but in the early stages when the displacement is not evident, or there is only the slightest prominence of the spinous processes, it is likely to be mistaken for a simple rachitic or statical curve; whilst if neuralgic pain is a prominent symptom, it may possibly be looked on as a case of spinal or intercostal neuralgia or rheumatism, or even ascribed to renal affections. Tumours of the spine, such as cancer, or hydatid cysts, syphilitic disease, and aneurismal erosion, also produce symptoms somewhat resembling those of spinal caries, and in adults it may be impossible to determine from the local phenomena alone which of these conditions is present, although a careful consideration of the general history and the onset of the symptoms may throw some light upon the case. Frequently the course of the disease and the reaction to treatment must be mainly relied on in forming a diagnosis. The spine should always be examined from before and from behind, and pain on pressure over the transverse processes and rigidity of the back are the symptoms on which most stress should be laid.

The diagnosis of the abscesses connected with spinal caries is sometimes not devoid of difficulty, especially when they point in the *groin* or the *lumbar region*, since similar collections of pus may arise from a variety of other causes. (*a*) A *perinephritic abscess* is recognised by the association or pre-existence of symptoms of renal disease, whilst a spinal lesion may be absent.

Of course, both conditions may be present in the same individual, and the diagnosis can then only be made by an exploration of the abscess cavity. (*b*) An *empyema* occasionally points in the loin or even in the groin, but should be recognised by an examination of the thorax. (*c*) A chronic abscess due to *appendicitis* may present very similar signs to those of a deep-seated abscess in the ilio-psoas region on the right side, which has not extended below Poupart's ligament. Careful examination, however, will demonstrate the extension of the abscess upwards in the latter case towards the spine, whilst the previous history will differ considerably in the two conditions. The character of the pus is, moreover, a distinctive element, in that it has an almost always offensive smell when due to appendicitis, on account of the presence of the *Bac. coli communis*. (*d*) An *iliac abscess* may arise from a variety of conditions other than spinal disease, *e.g.*, necrosis or caries of the ilium, or cellulitis in the tissues under the fascia iliaca. It is recognised by being, as a rule, more distinctly limited in extent than an ilio-psoas abscess, and by the absence of symptoms of spinal disease. (*e*) *Abscesses arising in connection with hip disease* occasionally point in the groin, but are easily distinguished from a psoas abscess by not extending upwards along the course of the psoas muscle, and by the evident signs of hip disease which are always present. (*f*) Diffused or *ruptured aneurism* of the iliac artery may give rise to considerable difficulty in diagnosis, since a non-pulsating tumour in the course of the muscle is sometimes produced. The preceding history, the absence of fluctuation, the œdema and congestion of the leg, the interference with the pulse, and the rapid increase of the tumour, should indicate the nature of the case. (*g*) The diagnosis of abscess from *femoral hernia* is given at p. 923.

Treatment.—The great essential in the treatment of spinal caries is absolute immobilization, perhaps associated with the application of some mechanical support, which shall take the weight of the body from the seat of injury. This may be effected in any of the following ways:

(*a*) *By the Adoption of the Recumbent Posture.*—The patient is kept in bed either in the prone or supine position, until the pain in the back has diminished to such an extent as to warrant the application of a spinal support. In any but the youngest children the prone position on a suitably constructed couch may be adopted with advantage, since by this means the weight of the body is more completely taken off the spine, whilst congestion of the diseased parts is less likely to occur, and, moreover, local applications, such as blisters, or even the actual cautery, can be made. In many cases it may be advisable to combine treatment in this fashion with the application of a removable poroplastic or leather spinal jacket. If thought desirable, extension by weight and pulley attached to the legs, as described at p. 411, may also be undertaken in these patients; pain and irritation due to the pressure of the diseased bones one on the other may be thereby minimized.

(*b*) *By the Application of Sayre's Plaster Jacket.*—If the disease exists in the dorsal region, the trunk is encased in plaster of Paris, which should extend from the axillæ to just below the iliac crests. The patient is stripped to below the waist, and a closely-knitted woollen vest fitted to the body, and fixed by straps passing over the shoulders. A pad or folded towel is placed beneath it over the abdomen to allow for distension after meals, and in women similar smaller pads may be placed over the mammæ to protect them. Coarse canvas bandages, into the meshes of which plaster of Paris has been rubbed, are thoroughly soaked in water, to which a little salt may be advantageously added, and then wound evenly round the body until a layer of five or six thicknesses is obtained. Over this a paste of plaster of Paris, prepared as described at p. 371, is laid, until the jacket has attained sufficient thickness and consistency. This is allowed to dry before the patient's position is altered. In adults, where the disease is chronic and not acute, the jacket should be applied whilst the spine is extended by suspending the patient by the head and axillæ from a suitably arranged tripod. In children, or when the disease is acute, it will suffice if the parent or an assistant partially supports the patient from the armpits, or the apparatus can even be applied with the child in the recumbent posture. The jacket must be worn until all pain and evidence of active disease have disappeared, and after that the patient should be fitted with a poroplastic support for a time. In disease of the cervical or upper dorsal vertebræ, a special jury-mast is required, in order to steady the head and take the weight off the spine (Fig. 285). It consists of an iron rod, fixed to a plaster or poroplastic jacket, accommodating itself to the curves of the head and neck; above, it extends forwards as far as the vertex, and has attached to its upper end straps, which pass downwards beneath the occiput and under the chin.

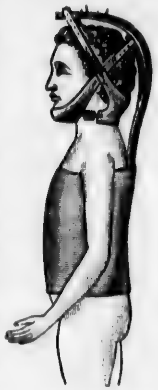


FIG. 285.—SAYRE'S PLASTER JACKET, WITH JURY-MAST FOR CERVICAL DISEASE. (TILLMANNS.)

(*c*) *By the Use of Phelps' Box.*—This plan of treatment, which has been advocated by Phelps of New York, consists of a wooden box 6 inches deep, the lower end of which is divided into two portions, one for each leg, a suitable aperture being left at the junction of the divided parts for the passage of the excreta. Careful padding is applied to the whole of the interior, and the child is strapped and bandaged into this apparatus, and kept there for a period varying from six to twelve months. The whole trunk is thus absolutely immobilized, and one great advantage is that the patient can be easily carried about in his box, and taken into the open air. Extension can also be made, if necessary, by elastic accumulators attached to the head and neck, or legs.

(*d*) In very young children perhaps the simplest apparatus is a double Thomas's splint, with a suitable crutch above to fix and support the head.

During the whole course of treatment, the general condition of the individual must be carefully attended to, and suitable food and tonics administered. Wherever possible, the child should be taken regularly into the open air, and in the later stages a change to the seaside is often most beneficial. When all symptoms of pain and irritation have disappeared, the patient may be allowed gradually to get about again with a mechanical support, and, indeed, this should not be dispensed with for six or eight months after apparently complete recovery.

Counter-irritation is but seldom required. It may be useful, however, where severe pain exists in the early stages, especially in adults. The best means to employ is the actual cautery, either applying a button cautery at several spots on each side of the spine, or searing the skin longitudinally.

The **Treatment of the Chronic Abscesses** so often met with in spinal disease is always a matter of some difficulty, since, when once opened, they usually take a considerable time to heal, and if allowed to become septic, the prognosis of the case is seriously affected. A general description of the methods employed has already been given at p. 48. Formerly, owing to the fear of sepsis, surgeons used to teach that the longer a chronic abscess remained unopened, the better for the patient; but at the present day the majority of cases are treated as soon as pus is diagnosed with certainty.

A *Retro-pharyngeal Abscess* should always be dealt with from the neck, as described at p. 731.

A *Dorsal*, *Lumbar*, or *Psoas Abscess* should be tapped with a large aseptic trocar and cannula; after the evacuation of the pus, the cavity is thoroughly washed out with a mild antiseptic lotion, or with sterilized water at a temperature of 105° to 110° F. In the case of a psoas abscess, the irrigation may be combined with gentle massage of the abscess cavity, in order to detach as far as possible the pyogenic membrane, and to assist in the removal of curdy débris. When the lotion returns uncoloured, or but slightly tinged with blood, an ounce or two of a 10 per cent. emulsion of iodoform in glycerine is injected, and diffused, if possible, through the abscess cavity by manipulation. The cannula is then withdrawn, and the external wound closed.

Occasionally a cure can be obtained in this way by one tapping, but only when no active disease is present, and when the patient's general health is good; more commonly the fluid will re-collect, and the same process may need to be repeated two or three times. Sometimes the fluid finds its way along the track of the cannula, and a sinus results; such must be dressed antiseptically until cicatrization has occurred. The best position in which to tap a psoas abscess is at a spot just internal to the anterior superior spine; a small incision is made in the skin, sufficient to allow of the insertion of the trocar through the abdominal muscles into the cavity of the abscess, but the surgeon must make certain that the intestines have been previously displaced to one side; as a rule, no fear need be entertained on this score, as the parietal peritoneum is always pushed inwards. If there is any doubt as to this, the abdominal muscles must be cleanly divided through an incision about 1½ inches long, and thus the abscess exposed. There is a greater likelihood of a sinus forming, however, if this is done.

Some prefer to open the abscess from the front, and scrape out its interior with a Barker's flushing gouge. Certainly by this means the tubercular pyogenic membrane and débris can be more thoroughly removed, but the sharp edge of the instrument is capable of doing a considerable amount of harm in this situation, and there is also a greater likelihood of a sinus remaining. Personally we are not in favour of its use for this purpose, and maintain that the method which we have advocated above is better, since there is less probability of an open wound persisting.

Occasionally it may seem advisable to freely open the sac of a psoas abscess, and where the disease originates in the lumbar vertebræ it has been recommended by Mr. Treves to cut down along the outer border of the erector spinæ, and deal with it from behind. A vertical incision is made in this situation, and after dividing the lumbar fascia, the abscess sac is easily reached and opened. The great advantage of this method is that the state of the bodies of the vertebræ can be ascertained; they can be readily scraped, and even sequestra removed.

When symptoms of paraplegia arise in the course of Pott's disease, it is usually unnecessary to do more than maintain the immobilization of the spine, since, as already stated, the natural tendency of these cases is towards recovery. At the same time, extra precautions should be adopted in order to prevent bedsores over the points of pressure. Should any difficulty in micturition arise, regular catheterism must be adopted, and the greatest care directed to the sterilization of the catheters, septic cystitis being always due to external contamination. In such cases it would be wise to thoroughly purify the penis, and to keep it covered with an aseptic dressing in the intervals between catheterism. Laminectomy (p. 515) is called for in order to relieve pressure upon the cord in the following cases: (*a*) When septic cystitis or the existence of deep bedsores is threatening life. (*b*) When, in spite of prolonged rest, the symptoms persist or increase. (*c*) When paraplegic symptoms develop late in the case, and are possibly due to a development of fibro-cicatricial tissue outside the membranes (peri-pachymeningitis). (*d*) Finally, whenever the tubercular process mainly affects the neural arches, there is no reason for not treating it according to the rules usually in vogue for dealing with it in other situations, viz., by operation.

III. **Syphilitic Disease** may involve the spine in the shape of gummata, commencing beneath the periosteum covering the bodies; it is of unfrequent occurrence, and gives rise to symptoms exactly similar to those of tubercular caries, from which, indeed, the condition cannot be diagnosed, except by the history and its reaction to treatment. It usually occurs in adults. Suppuration and abscess formation are not commonly observed. The co-existence of a syphilitic history and of specific lesions elsewhere may help one in coming to a conclusion.

Treatment consists in the administration of suitable anti-syphilitic drugs, and in the use of a spinal support.

IV. **Rheumatic Spondylitis** is a condition occasionally met with arising from the same causes, and associated with much the same phenomena as rheumatism elsewhere. It may involve either the ligamentous or muscular tissues, or may attack the intervertebral joints. Any part of the spine is involved, but perhaps the most marked features are presented in the cervical region. Considerable impairment of movement in the head is then produced, and the neck may be laterally deflected, somewhat simulating torticollis. If untreated, adhesions form between the bones, and the loss of movement may be permanent. The treatment is of an ordinary antirheumatic nature.

V. **Osteo-arthritis** sometimes attacks the vertebral column, leading to destruction of the intervertebral discs, and of the articular cartilages, together with erosion of the bones and the formation of osteophytic masses around. A large portion, if not the whole, of the spine is usually involved by this disease, and a prominent feature is the almost invariable supervention of ankylosis, either from ossification of the anterior or posterior common ligaments, or from interlocking or fusion of osteophytes. A marked kyphosis results, and great pain is present. Finally, the process spreads to the articulations between the ribs and the vertebræ, and when these become fixed the respiration is considerably impaired, and hence death is likely to ensue from pulmonary mischief. Treatment is as for similar disease elsewhere.

Tumours of the Spine are usually malignant in character, and most commonly secondary to cancer or sarcoma elsewhere. Simple tumours, such as osteoma and hydatid cysts, do occur, as also primary sarcoma. The chief symptoms are severe and localized pain, which is constant, and unrelieved by rest in the recumbent posture, together with early excurvation and paraplegia. These three phenomena manifesting themselves in an adult should always suggest the presence of a morbid growth. Treatment necessarily is but rarely feasible, although an exploratory operation is quite justifiable if the patient is not profoundly cachectic from the generalization of the disease.

Tumours of the Spinal Cord and Membranes may develop in several distinct situations, and the symptoms are thereby somewhat modified. (*a*) *Outside the spinal dura.* Lipoma and sarcoma are here most often seen, and the symptoms of cord pressure, such as loss of power and sensation, are preceded by those of spinal irritation, *e.g.*, neuralgic pain, increased on movement, and often limited for some time to one side. (*b*) They may grow *from the inner aspect of the dura mater*, and thus produce symptoms of cord pressure and meningeal irritation concurrently. Sarcoma, gummata, and fibromata are the commonest forms of neoplasm in this situation. (*c*) *From the spinal cord* itself, myxoma, psammoma, and sarcoma may originate. The symptoms are those of paraplegia combined with some localized and referred pain or tenderness, and usually bilateral from the start. Left to themselves, patients suffering from any of these growths are certain to die, and hence an exploratory laminectomy, with a view to removal of the growth, if practicable, is always indicated when a diagnosis has been effected. The possibility of the disease being syphilitic in origin must not be overlooked, and hence a preliminary thorough course of iodide of potassium should always be instituted before operating. The results hitherto obtained have been distinctly encouraging, although many of the cases are left till too late, and the mortality is certain to be high.

The only inflammatory disease of the cord which need be alluded to here is one the results of which have already been mentioned constantly in the chapter dealing with the deformities of the body (Chapter XX.), viz., **Infantile Paralysis**. This condition is due to an inflammation of the anterior cornua of the grey substance of the cord (anterior poliomyelitis), as a result of which the multipolar ganglion cells situated therein are destroyed. The symptoms come on abruptly, and are often introduced by a short febrile attack; paralysis shows itself at once, and quickly attains its maximal proportions, being possibly followed by a certain amount of recovery. The portions that remain paralyzed early lose their nutrition, owing to the destruction of their trophic ganglionic centres, and become cold and bluish in colour; finally, deformities due to the unbalanced action of opposing groups of healthy muscles may appear, or impaired development or growth of the limbs follows. The distribution of this affection is very variable, but, speaking generally, the legs are most commonly affected, the lower halves, and not the upper, being mainly involved; various forms of talipes may result therefrom, as also weak and flail-like conditions of the knee and ankle. When the thigh is included, the extensor muscle of the knee and the adductors are usually picked out. In the arm the deltoid is most often paralyzed, and after this the muscles on the extensor side of the forearm, excluding the supinator longus. The face and neck are rarely involved, but the abdominal and back muscles may be attacked. The **Treatment** in the early stages is directed towards improving the general health, and maintaining the nutrition of the affected muscles as far as possible by electricity and friction. In the later stages, when deformed or weak and flail-like limbs have resulted, various means may be adopted in order to improve the functions of the part. (*a*) *Mechanical support* is often needed, and this must be carefully regulated, in order to assist, and not to hamper, the movements of the individual by any unnecessary weight. In paralytic talipes, irons fixed to the boots, and rising above the knee, or even sometimes running up to the pelvis, are frequently required. (*b*) *Tenotomy*, or division of muscles or fasciæ, may also be called for in certain deformities. (*c*) *Arthrodesis*, or the fixation of joints, is a useful proceeding under circumstances where the unnatural mobility is difficult to control, or would necessitate considerable increase in the weight of the apparatus required, or where, from the poverty of the patient, the apparatus cannot be obtained. It is especially serviceable in cases where two joints in a limb are flail-like, one of which may then be ankylosed with advantage. The operation consists in a modified excision, the cartilage alone being sawn or scraped from the ends of the bones. (*d*) Where the whole limb is hopelessly paralyzed, and a great inconvenience to the patient, *amputation* is often the best practice.

CHAPTER XXX.

ABDOMINAL SURGERY.

Injuries of the Abdominal Walls.

ABDOMINAL injuries may be divided into three main classes—contusions, non-penetrating and penetrating wounds.

Contusions of the abdominal walls vary in their results with the cause and character of the injury. If due to a slight blow, the effects are probably not serious, the patient merely suffering from pain and bruising, as in any other part of the body; but if the blow, although slight, falls upon a distended viscus, such as the stomach or bladder, the organ may be torn, and the contents extravasated into the abdominal cavity, with fatal results from peritonitis; an account of these visceral injuries is given *seriatim* under the appropriate headings in this chapter. Any sudden sharp concussion, especially if directed to the epigastrium, is liable to be followed by severe shock from irritation of the subjacent solar plexus of sympathetic nerves, and life itself may be destroyed in this way by syncope without the appearance of any evident lesion.

In other cases the injury may be limited to the abdominal walls, leading to rupture of one or more of the constituent muscles, especially the rectus. A hæmatoma of considerable size usually follows, and such is especially liable to suppuration and the formation of an abscess, which may point directly at the injured spot, or burrow widely between the muscular planes. The smell of the pus is always suggestive of the presence of the *Bac. coli*, and this organism probably finds its way into the extravasated blood from some slightly damaged coil of intestine in the neighbourhood. As a further complication, laceration of the parietal peritoneum may be mentioned, causing great shock and intraperitoneal extravasation of blood; if such is abundant, as from a large vessel, peritonitis is almost certain to follow.

The **Treatment** of an abdominal contusion is always a matter of some anxiety to the surgeon, as it is difficult at first to make certain of the exact nature of the injury, and as to whether or not visceral complications are present. In the more simple cases, all that is needed is to put the patient to bed, combating shock in the usual way by the application of warmth, but stimulants should be avoided, if possible, for fear of restarting hæmorrhage. In the more severe cases, a thorough examination of the abdomen should be made, and the conditions there found, and the symptoms present, must be most carefully and anxiously weighed. A decision has to be arrived at as to whether expectant treatment is to be depended on, or whether an exploratory laparotomy is to be undertaken. No absolute rules can be laid down as to when operation is called for, but the surgeon should remember that an unnecessary exploration in a doubtful case will probably do far less harm than delaying operation until the diagnosis is made certain by an outbreak of diffuse inflammation, providing always that the patient is not so profoundly collapsed as to contra-indicate all interference. The examination of the abdomen and of the patient may bring to light facts which make operation essential, such as severe intraperitoneal hæmorrhage, general tympanites or free air in the peritoneal cavity as indicated by loss of the area of hepatic dulness, blood-stained vomiting, or the phenomena due to a lacerated bladder. Under such circumstances, no delay is justifiable, and, even if severe shock is present, operation should be commenced, unless death is evidently imminent. A large intravenous injection of hot saline solution will usually rally the patient sufficiently to warrant the surgeon in proceeding, whilst freely washing out the peritoneal cavity with the same hot solution has often a similar effect. If, however, well-marked shock is present, with perhaps localized pain, but with no absolute evidence of visceral lesions, expectant treatment should be adopted. The patient is kept warm in bed; perhaps a little opium is administered to allay pain and restlessness and to check peristalsis, but as little as possible should be given, since symptoms are so completely masked thereby. If there is any vomiting, rectal alimentation should be employed after the lower bowel has been washed out. If, at the end of twenty-four hours, the patient is still in a condition of collapse, and especially if manifestations of intraperitoneal hæmorrhage or of commencing peritonitis have made themselves evident, operation can still be undertaken with some prospect of success.

Non-Penetrating Wounds of the Abdominal Wall do not demand separate attention, since there is no special significance about them, and if uncomplicated by contusions are treated on general principles. If the epigastric artery is divided, extensive extravasation is likely to ensue, and the wound must then be enlarged, and the bleeding-points secured. It must also be remembered that the sheath of the rectus is divided anteriorly by the lineæ transversæ into separate compartments; but as these do not extend through the whole thickness of the muscle, collections of blood or pus may be limited anteriorly, whilst behind they may become diffuse. If the abdominal muscles are widely divided, steps should be taken, after thorough purification, to draw the severed muscular or aponeurotic fibres together by deep stitches, so as to diminish the tendency to a ventral hernia.

Penetrating Wounds of the Abdominal Wall may occur with or without injury or protrusion of the abdominal viscera. In all cases there is a certain amount of hæmorrhage, greater or less according to the size of the vessels divided, and of shock, which latter is very marked when the viscera are injured, whilst mere protrusion without injury may cause but little effect. Thus, cases are on record in which a patient has walked to the surgeon for treatment, carrying some coils of intestine in his hands. As a rule, however, the protruded viscera, usually small intestine or omentum, are large in amount compared with the size of the opening, causing them to be more or less congested, or even strangled. Necessarily, in all cases the great danger is that of diffuse septic peritonitis (*q.v.*), caused either by rupture of the intestine or by infection from without.

The **Treatment** of these abdominal wounds has been entirely altered in recent years, as a result of increased confidence in antiseptic methods. The external wound is carefully cleansed, whilst protruding viscera are similarly purified. If omentum projects, it is wise to ligature and remove it, whether it is injured or not. Intestine should be carefully washed with weak antiseptic lotions, such as boric acid lotion, carbolic (1 in 60), or sublimate (1 in 2,000), and then replaced; if slightly bruised, it may be returned, although it is wise to keep it by a catgut suture near the external wound, which should not be entirely closed, so that if fæcal extravasation occurs a ready exit is provided. Small incisions or punctures must be sutured, but when intestine is hopelessly damaged, enterectomy should be undertaken if the patient's general condition is sufficiently good; but if unfit to undergo such an operation, the gut must be fixed in the wound as in colotomy, and the defect dealt with at a subsequent period.

In cases where it is not certain whether the peritoneum has been implicated, the surgeon should always enlarge the wound so as to make sure, and if the serous membrane has been involved, he should carry his investigations still further, and ascertain, if possible, whether any damage has been done to the viscera.

The external wound must (with the exception mentioned above) be carefully closed with sutures, so as to minimize the risk of a subsequent ventral hernia. The peritoneum is first dealt with, and then the divided muscles are united by buried stitches of catgut or well-boiled silk, and finally the skin is brought together with a continuous suture. A drain-tube may need to be inserted for a time.

There are but few other conditions of the abdominal wall which require notice. The rectus muscle may be torn as a result of injury or tetanic convulsions, and a hernia is very likely to follow such a condition. One of the segments may become spasmodically contracted, constituting what is known as a 'phantom tumour,' usually occurring in hysterical females, and disappearing under an anæsthetic.

Affections of the Umbilicus.

The various forms of umbilical herniæ are described at p. 924.

Inflammation and **Ulceration**, perhaps running on to eczema, may arise from want of cleanliness after separation of the cord. Tetanus neonatorum probably owes its infection to this source, as also the erysipelas of infants, both of which diseases are exceedingly fatal, whilst the latter is often accompanied by sloughing of the neighbouring abdominal parietes. The eczematous condition merely requires cleanliness, and the application either of an antiseptic dusting-powder or of some simple ointment.

Occasionally a **Polypoid Excrescence** is met with growing from the umbilicus, and is probably derived from the remains of the umbilical vesicle. On microscopic examination, it is found to consist of a number of tubular glands held together by connective tissue. All that is required is to ligature the base and cut it away.

Warts and **Nævi** are also found here, but need no special notice, as also syphilitic and epitheliomatous disease.

Umbilical Fistulæ not unfrequently occur, and may be congenital or acquired. Three varieties are described:

(*a*) *Fæcal Fistulæ* of congenital origin arise from non-closure of the vitello-intestinal duct, and either open into the intestine directly, or by means of a passage of greater or less length, which corresponds to Meckel's diverticulum, and is connected with the lower part of the ileum. Acquired cases are usually due to perforation of the bowel following strangulation of an umbilical hernia, or to tubercular peritonitis.

(*b*) *Urinary Fistulæ* may be met with as congenital deformities, due to non-closure of the urachus; occasionally there is no communication with the bladder, merely a sinus existing leading towards the bladder. They may be dealt with by ligature of the mucous membrane, its destruction by the galvano-cautery, or by freshening the edges, and subsequent suture.

(*c*) A *Biliary Fistula* may sometimes form at the umbilicus, probably resulting from the bursting of abscesses in connection with the gall-bladder.

In **Ectopia Vesicæ** (p. 1003) the umbilicus is absent, the extroverted portion of the bladder extending up to what should normally be its situation.

Affections of the Peritoneum.

Inflammation of the peritoneum, or **Peritonitis**, may arise from a variety of conditions, and may present many diverse manifestations. It is a disease which may be limited to some particular locality, or may involve the whole serous membrane. In discussing the subject, we shall avail ourselves of the large mass of information gathered together by Mr. Frederick Treves in the Lettsomian Lectures for 1894, which represent some of the latest ideas on the subject.

From an **Ætiological** point of view, it may be stated that peritonitis is almost invariably due to the action of micro-organisms, the symptoms being largely those of toxic poisoning, death, when it occurs, resulting from toxæmia rather than from the inflammation.

The following forms may be distinguished:

1. Peritonitis due to infection from the intestine, the organism usually present being the *Bacillus coli communis*. Entrance to the peritoneal cavity may be gained either through some actual breach of surface, such as a penetrating wound or perforating ulcer, or through an intestinal wall, the resisting powers of which have been diminished by inflammation or injury. The peritonitis associated with appendicitis, or secondary to strangulated hernia, is of this type.

2. Peritonitis due to infection from without, the ordinary pyogenic organisms being present, especially the *Streptococcus pyogenes*. Such occurs in penetrating or operation wounds where the bowel is uninjured, as also in puerperal peritonitis.

3. Peritonitis may be due to the gonococcus, which has travelled up the Fallopian tube from the vagina.

4. Tubercular peritonitis also occurs, and is usually chronic in type.

5. There is a group of cases in which peritonitis is of doubtful origin, possibly arising from chemical or local irritants, rheumatism, etc.; but it is still a moot point whether such can be caused apart from the activity of micro-organisms.

Clinical History.—From a purely clinical standpoint, the origin of peritonitis is of comparatively little importance, since the symptoms produced are very similar in the different groups indicated above. It may be practically discussed under two main headings—the acute and the chronic. The acute is again divided into the diffuse and localized, and the chronic into the simple and the tubercular.

Acute Diffuse Peritonitis.—The onset varies somewhat with the cause of the affection; but when due to traumatic infection from without, the symptoms usually commence with abdominal pain and distension, together with flatulence and vomiting. The pain may at first be localized to some particular region, or referred to the umbilicus; it soon, however, becomes diffuse, and is associated with exquisite tenderness and great distension. In a typical case the phenomena are very characteristic. The patient lies on his back with the knees drawn up, partly to relax the abdominal muscles, partly to prevent the bedclothes touching the body. The abdomen is distended, hard, and extremely tender; it is at first generally tympanitic, but later on, if effusion should become marked, dulness may be noted in the flanks, although this is not a common feature. The pulse is quick, hard, and wiry at first, though later it becomes weak, rapid, and compressible. The respirations are quick, shallow, and thoracic in character. The temperature, raised at first, tends to become subnormal from toxæmia before the end is reached. Vomiting is usually a prominent symptom, associated perhaps with hiccough; in the early stages the contents of the stomach alone are expelled, but later on they may be mixed with bile, or even fæcal material. Though very constant and troublesome, it is much less distressing than that which arises from intestinal obstruction, and, owing to the pain induced by any sudden contraction of the abdominal muscles, the patient ejects the vomit with but little force. Constipation and arrest of flatus are always present in peritonitis, owing to the cessation of peristalsis induced by the inflammation. As the case progresses, the patient's strength rapidly diminishes, his face becomes pinched and drawn (*facies Hippocratica*), the extremities are cold, the temperature is usually subnormal, and death results from collapse and toxæmia.

When due to sudden perforation of the bowel, the onset of the symptoms is associated with profound shock, and the course is very rapid if the opening is large, and the intestinal contents early extravasated. Vomiting, too, is usually more marked than when due to other causes. If, however, the perforation is small, there is much less immediate shock, and the symptoms progress more gradually.

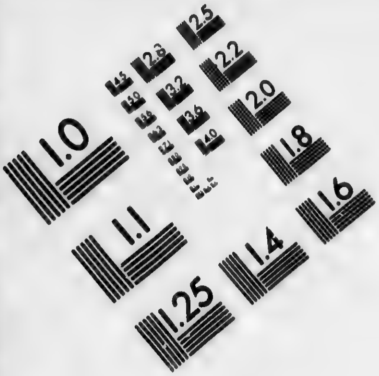
The **Post-mortem Phenomena** of acute diffuse peritonitis consist in an exudation into the peritoneal cavity of turbid serum or pus, mixed with flocculi of lymph. The serous coat of the intestine is roughened, and adjacent coils may be matted together by greenish semi-puriform lymph. The effusion is mainly found in the pelvis and lower part of the abdominal cavity, and is not always very abundant; it is intensely infective, and any wounds caused during the performance of the post-mortem examination are likely to be followed by severe cellulitis, or even fatal septicæmia.

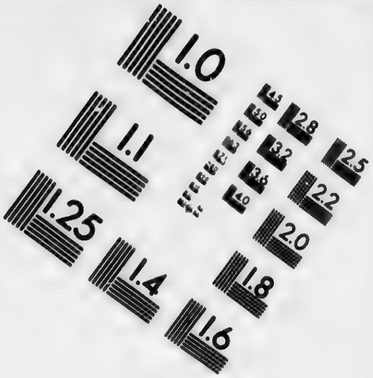
Treatment of Acute Diffuse Peritonitis.—In former days treatment consisted in fomenting the abdomen, and keeping the patient fully under the influence of opium, whilst abstinence from food was enforced, and possibly calomel given as an absorbent; but in view of the fact that peritonitis is very rarely idiopathic in nature, and usually results from some very definite local lesion, such measures rarely suffice to fulfil the requirements of practitioners at the present day. In diffuse peritonitis, expectant treatment of this character is almost certain to be followed by a fatal issue; and although treatment by operation has no great results to boast of, it is the only rational and scientific plan to adopt. The virulent nature of the toxines produced by the inflammatory process, and the late date at which operation is usually performed, fully suffice to explain the high death-rate associated with it. An exploratory laparotomy should therefore be undertaken as early as possible, the incision being made in the linea alba, and usually below the umbilicus, unless there is tolerably clear evidence that the causative lesion is in the upper part of the abdomen. The effusion is allowed to escape, and by gently separating the coils of intestine localized pockets of fluid may be evacuated. Collections of blood or pus should be swabbed out by gentle sponging, or possibly general irrigation of the abdominal cavity with sterilized salt solution (0·6 per cent.) may be adopted. In this proceeding care must be taken to maintain the fluid at a constant temperature (105° to 110° F.), to prevent abdominal distension, and not to allow the fluid to play on the under surface of the diaphragm for fear of causing respiratory embarrassment. If the original lesion can be reached without much difficulty, it must be dealt with according to the rules given hereafter, provided that the patient's general condition is sufficiently satisfactory. Drainage of the peritoneal cavity by a glass drainage-tube, or perhaps better by strips of gauze passed amongst the intestines in different directions, is usually essential.

In cases of incipient peritonitis following abdominal operations, the chief causative factor is often a paralytic condition of the gut, which permits of the retention and decomposition of the intestinal contents, thus assisting the activity of the *Bac. coli.* In such cases a smart saline purgative is often useful, in order to free the intestine from its irritating contents. When, however, general septic peritonitis is present, purgatives can only do harm.

Acute Localized Peritonitis usually arises in connection with some localized lesion of the abdominal contents, which is of such a nature as to permit of the general peritoneal cavity being shut off by adhesions between adjacent coils of intestine, the process being thereby limited. It is usually, although not invariably, followed by suppuration, the abscess being thus intraperitoneal, although not involving the general peritoneal cavity. The abscesses arising in connection with appendicitis or pelvic peritonitis are not uncommonly of this nature. They may burst through the barrier of adhesions, and thus light up a diffuse inflammation of the peritoneal sac, or they may burrow to the surface and burst externally, or open into one of the hollow viscera.

The **Symptoms** complained of are deep pain and tenderness, more or less localized, referred to the affected spot, together





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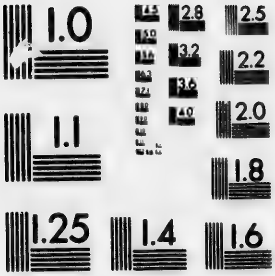

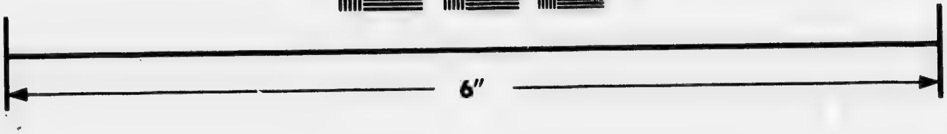

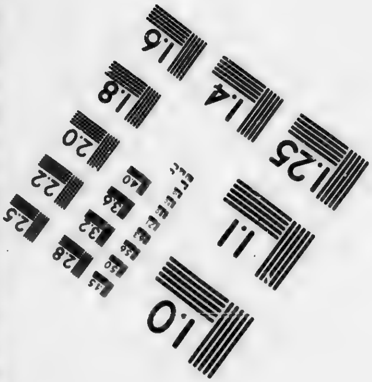

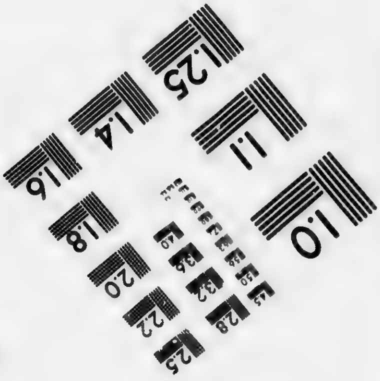

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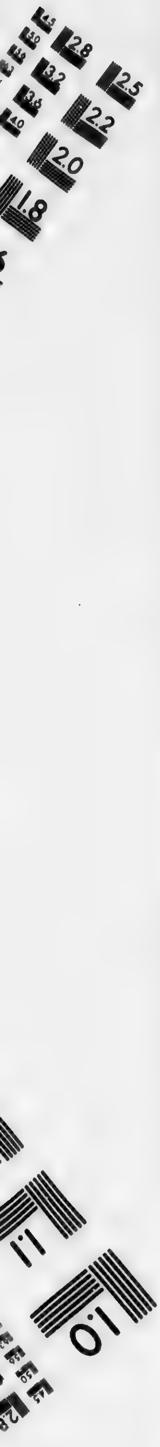
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with fever, vomiting, and constipation. At first no swelling or tumour is to be made out, but a feeling of resistance may be noticed in the abdominal walls, which are held tense and rigid, as if guarding the affected spot. As the effusion increases in amount, a tumour dull or tympanitic on percussion usually becomes evident; it is mainly due to a matting together of the intestines, but with a variable amount of effusion associated. If the abscess travels towards the surface, the abdominal wall becomes infiltrated, red, and œdematous, the component tissues being brawny to the touch, and cutting like bacon. Finally a fluctuating area presents itself in the midst of this indurated mass, and the abscess either discharges itself or is opened. The pus contained therein may be thin and offensive, or it may be free from odour, and then is often somewhat inspissated, and like custard in consistency. Of course this process is attended with considerable increase in the pain and constitutional disturbance. If the cavity is treated antiseptically, it rapidly contracts and a cure is accomplished, although intraperitoneal adhesions may persist and lead to trouble later on from hampering the intestinal movements. If a communication is established with the intestine, a fæcal fistula is very likely to follow; whilst if the cavity becomes septic, chronic suppuration may result, and thereby the patient's health and strength may be undermined.

Treatment of Acute Localized Peritonitis.—In these cases, resolution can be obtained in favourable cases by keeping the patient quiet and on a low diet, with perhaps a little morphia, and applying hot fomentations locally, whilst the lower bowel is emptied by an enema. Such a course must, however, not be persisted in for too long when suppuration is likely to have occurred, for fear of the inflammation spreading to the general peritoneal cavity, or of the abscess bursting into it. An early exploratory laparotomy is advisable under such circumstances. The line of treatment marked out for appendicitis (p. 886) is that which should always be followed.

Simple Chronic Peritonitis in itself rarely requires surgical attention, since it is to be looked on rather as a protective than as a destructive process. It is characterized by infiltration and thickening of the peritoneum, giving rise to adhesions, whereby the intestinal wall is strengthened, and bacterial invasion limited. It is localized or diffuse in character, and arises either as a result of pre-existing acute inflammation or as a primary affection. In the more diffuse forms the intestines are hopelessly matted together, and the omentum may be rolled up and contracted into a rounded cord-like mass, lying in the upper part of the abdomen; chronic obstruction is almost certain to arise sooner or later from this condition. Occasionally the existence of persisting localized pain may indicate the presence of a solitary adhesion, passing between the abdominal wall and one of the viscera, such as the anterior wall of the stomach. In such cases an exploratory laparotomy is permissible, the adhesion if found being divided between ligatures. The importance of dealing with such adhesions, where possible, is evident from the fact that internal strangulation beneath them, or acute kinking of the gut over them, is one of the commonest forms of acute obstruction.

Tubercular Peritonitis.—In this disease the peritoneum becomes either studded with miliary deposits, giving rise to considerable serous effusion (ascitic variety), or may be occupied by larger caseous masses undergoing suppuration and ulceration, the viscera in such a case being partly matted together, with suppurative foci intervening (ulcerous form). If the disease tends to recovery, numerous fibrous adhesions are found, matting the intestines together (fibrous variety). It may perhaps develop as a primary affection, but is more usually secondary to tubercular ulceration of the intestine, or to a similar disease of the mesenteric glands. The *symptoms* are very variable. Any and every form of digestive disturbance may occur, including alternating attacks of constipation and diarrhœa, with some amount of colic and vomiting. The onset is generally gradual, but intermissions and relapses are of frequent occurrence. Wasting is, however, always a marked feature. The abdomen is usually enlarged, perhaps tender to the touch, and may contain free fluid or not. This affection is usually seen in young patients, and may be associated with tubercular disease elsewhere.

Treatment in the early stages is often successfully undertaken by the physician; but if the condition is progressing, the surgeon may be called upon to deal with it by laparotomy. When marked ascitic accumulation is present, all that is needed is to evacuate the fluid and to close the wound with or without irrigation, and in nearly 75 per cent. of the cases a cure may be anticipated. Where diffuse or localized suppuration is present, adhesions which can be reached may be gently broken down, exit given to the pus, and the peritoneal cavity washed out; but no prolonged search after suppurating foci should be made. The results of treatment in this variety are not nearly as satisfactory as in the former, at least 40 per cent. of the cases dying. As to the way in which cure is established opinions differ, some authorities considering that it is due merely to the admission of atmospheric air, some to the alteration produced in the intra-abdominal tension, whilst others maintain that it is simply in consequence of the removal of the exudation and its contained toxines.

Paracentesis Abdominis is called for in cases of general or encysted ascites. The usual plan adopted is to seat the patient on a chair, and to encircle the abdomen with a flannel binder, the ends of which are split to within 6 inches of the middle line. The unslit portion is placed over the abdominal wall in front, whilst the divided portions cross behind, and are held by assistants, so as to make continuous pressure upon the abdominal contents. The abdomen is carefully percussed, and a spot of absolute dulness selected; here a small skin incision is made with a scalpel, and a suitable trocar and cannula inserted. The median line below the umbilicus is the place usually chosen for the puncture, but there is no objection to inserting the trochar through the flanks. Some surgeons prefer to withdraw the fluid more slowly, so as to prevent the shock often experienced from its rapid evacuation. Two or three Southey's trocars and cannulæ may then be inserted.

Affections of the Stomach.

Rupture of the Stomach results from blows or falls upon the epigastrium, especially after a heavy meal, and then usually involves the pyloric end or the greater curvature near the cardiac orifice. It may also follow a penetrating injury, such as a stab or a fall upon a spike or railings.

The **Symptoms** are those of severe and prolonged shock, with epigastric pain and vomiting, the ejected material often containing blood; acute septic peritonitis usually ensues in a very short time, destroying the patient's life in a few days. Occasionally, when the wound is small, or the organ empty at the time of the accident, there is but little or no extravasation, and then a localized intraperitoneal abscess may form, shut off from the general peritoneal cavity by adhesions, and sooner or later bursting and discharging into the stomach, colon, or one of the hollow viscera, or else tracking along the parietal wound so as to reach the surface, or even sometimes breaking down the barrier of adhesions, and originating a late general peritonitis. If the posterior wall of the stomach is alone injured, the resulting phenomena are very similar to those due to the perforation of an ulcer (*q.v.*).

Treatment.—When a wound perforating the abdominal parietes is present in the region of the stomach, it is always the surgeon's duty to enlarge the opening, and ascertain what amount of internal damage has been done; but if there is no external wound, or merely a superficial one, a certain diagnosis cannot be made as long as the shock continues. If, however, it persists for some considerable time, and evidences of the onset of peritonitis manifest themselves, an exploratory laparotomy should be undertaken. No time should, however, be lost in cases where the diagnosis is tolerably certain, since the only hope of saving the patient's life lies in early interference. A median incision is made above the umbilicus, the situation of the injury in the stomach ascertained, and the aperture clamped by forceps so as to prevent any further exit of the gastric contents whilst the peritoneum is being cleansed. All the extravasated material should be carefully sponged or swabbed away, and if the general cavity has not yet become infected, irrigation should be avoided for fear of carrying infective material to other regions. The wound in the stomach is closed by a row of Lembert's sutures, which tuck the margins inwards, and these must extend a little beyond the lesion on either side (Fig. 292). If the posterior wall is also injured, as by a bullet wound, an opening should be made through the omentum so as to explore and cleanse the lesser sac of the peritoneum. If the case has been operated on early and the condition of affairs is not very serious, the peritoneal inflammation not having extended to any great degree, it may be possible to close the parietal wound entirely; but, as a rule, it will be necessary to drain the upper part of the serous cavity by inserting a plug of gauze down to and around the site of the injury. If the general cavity is inflamed, the treatment suitable to acute peritonitis must be instituted (p. 838). It will probably be wise under these circumstances to place a drainage-tube immediately above the symphysis pubis, as well as leaving the upper incision partly open.

Foreign Bodies in the stomach consist either of those which have been swallowed accidentally or intentionally, or of concretions, *e.g.*, hairs, wool, etc., due to the constant ingestion of small portions which remain in the viscus, and may after a time form large masses. The presence of the former is known from the history, whilst the latter may give rise to symptoms of gastric irritation, the cause of which is inexplicable until the mass has attained such a size as to suggest the presence of a tumour. The only treatment possible where the foreign body is of any size is to open the organ and remove it (gastrotomy); where, however, it is of small dimensions, *e.g.*, coins, it may be safely allowed to pass onwards.

Ulcer of the Stomach.—Until recently this affection was considered as belonging exclusively to the realm of the physician, but within the last few years, since we have acquired greater confidence in the exploration and treatment of the abdominal viscera by laparotomy, it has frequently come under the care of the surgeon. Into the ætiology and special symptoms of this condition, it is unnecessary to enter; they are described sufficiently in ordinary medical text-books. There are, however, several complications which may call for surgical treatment, viz., excessive hæmorrhage, perforation, cicatricial stenosis, and adhesions between the stomach and parietes.

1. *Excessive and Persistent Hæmorrhage* may so weaken the patient as to lead to a fatal issue. Nothing can be effected by surgical means in the majority of cases, owing to the impossibility of locating the lesion in the stomach; but in a few instances that have been recently recorded, the stomach was so distended that there could be no doubt that the ulcer was in the neighbourhood of the pylorus, which orifice was becoming constricted by cicatricial contraction. Under such circumstances the medical attendant

was quite justified in urging an operation, and Küster successfully opened the stomach in two such cases, finding the ulcer where he had expected it; the base was carefully cauterized, and no further bleeding ensued. In one of the patients a plum-stone was found imbedded in the sore.

2. *Perforation of the Ulcer* is by no means an uncommon occurrence, and must always be looked on as fraught with the greatest danger. The anterior wall is that most frequently involved, owing to its greater mobility preventing the formation of protective adhesions, which usually occurs on the posterior surface. The cardiac end is more often affected than the pyloric. The character of the symptoms varies with the size of the perforation, and with the distension or not of the viscus. If a large opening is produced in the anterior wall, so that the gastric contents are allowed a free entrance into the peritoneal cavity, the patient is seized with severe epigastric pain and profound shock, and this is followed at once by the signs of acute septic peritonitis, which rapidly proves fatal if surgical interference is not at hand. The onset is subacute when the perforation is small, and only a gradual leakage occurs; the primary shock is then inconsiderable, but epigastric pain and tenderness are present, and steadily increase until the characteristic features of general peritonitis supervene. Occasionally even with the anterior wall, the ulcerative process may extend so slowly that there is time for protective adhesions to form, and thereby shut off the general serous cavity from the inflammatory process; a localized abscess may then develop, and find its way either through the anterior wall, or it may burst into one of the hollow viscera in the neighbourhood.

When the ulcer involves the posterior wall of the stomach, the lesser sac of the peritoneum usually becomes obliterated by the formation of adhesions between the serous coats which form its boundaries, and when perforation occurs, or when the ulcer has extended sufficiently deeply, the retroperitoneal tissues are thereby opened up, and the pus and gastric contents travelling up between the liver and diaphragm may give rise to an abscess containing pus and gas, which is known as a *subphrenic pyopneumothorax*. This usually extends forwards, and points on one or other side of the ensiform cartilage; the pleural cavity also becomes involved in the inflammatory process, either by pus finding its way directly through the diaphragm, or by lymphatic absorption, giving rise to a basal empyema. In some cases the pus, instead of burrowing upwards, finds its way down behind the peritoneum, so as to point just above the iliac crest. The symptoms of a subphrenic pyo-pneumothorax are simply those which always arise in connection with a deep acute abscess, together with irregular areas of dulness and resonance over the focus of mischief; the liver dulness may be entirely obscured by the gas within the abscess cavity, and the organ itself displaced downwards.

The *Prognosis* of gastric perforation is exceedingly grave, since, unless active surgical interference is obtainable within a comparatively short time, hopeless peritonitis ensues. Barling states that 95 per cent. of patients that are untreated are sure to die, whilst the later the operation, the worse the results.

Treatment.—Should it be decided for any particular reason not to operate in a given case, the horizontal position, rectal feeding, and the use of morphia to check peristalsis, are the only means which hold out any prospect of benefit. Operation, as already indicated, must be undertaken at as early a period as possible, although it is often wise to delay for an hour or two to allow the patient to recover in measure from the initial shock. The median incision is the best to employ, since it is not possible to be certain as to the situation of the lesion. The rules given above as to the treatment of a penetrating injury also hold good in connection with this subject, especially as to the use of swabs for the removal of any extravasated gastric contents, and as to the value of peritoneal irrigation. There is no need to excise the ulcer when found; all that is required is to close the aperture by means of Lembert's sutures, applied perhaps in a purse-string fashion, so as to bury the ulcerated surface. In some cases it may seem unwise to attempt closure of the lesion, and then the opening in the stomach should be stitched to the abdominal wall, and a drainage-tube inserted so as to relieve gastric tension. The fistula thus formed is usually closed without much difficulty at a subsequent date. The treatment of subphrenic pyo-pneumothorax consists in opening the abscess wherever it is most accessible. Opinions differ as to whether it is necessary to make a counter-opening behind; in all probability, it is wiser not to attempt this at first, but if the temperature still keeps up, and the cavity does not seem to drain well after a few days, then further interference will be called for. The best situation for a counter-opening is in the mid-axillary line on the right side, a portion of the eighth or ninth rib being excised. If, as often happens, there is also an empyema, this is readily accomplished, and an additional opening can be made through the diaphragm if one does not already exist; if, however, the pleural cavity is not affected, then the serous membrane covering the upper surface of the diaphragm must be stitched to the parietal pleura before the diaphragm is incised.

3. *Stenosis* is always liable to occur after ulcers of the stomach, as in other situations. If it is located near the pylorus, that orifice may become contracted, giving rise to special symptoms, and necessitating treatment of a particular character (p. 850). Occasionally, however, the fundus may be chiefly involved, and then an hour-glass contraction of the viscus may occur, which in some cases is so marked as almost to divide the organ into two halves, only a narrow neck persisting between the two. The

symptoms of such a condition are almost identical with those of pyloric stenosis, and the treatment required consists either in excision of the sulcus, and reunion of the gastric walls, or in establishing an artificial opening between the two segments as by a Murphy button.

4. In a few cases *Adhesions* may form between the anterior wall of the stomach and the parietal peritoneum, owing to a plastic peritonitis over the situation of an ulcer. Such will give rise to a localized fixed epigastric pain, usually increased considerably by distension of the organ. It may be treated safely by abdominal section, and division of the adhesion between ligatures. If left alone, not only may it cause inconvenience by the pain induced, but it may also determine internal strangulation or obstruction.

Operations upon the Stomach.

1. **Washing out the Stomach** is needed in cases of poisoning, in chronic catarrh, in dilatation of the organ, and as a preliminary to operations in which its cavity is to be laid open. It may be accomplished by the ordinary stomach-pump, or by the simpler method of passing a long tube of good-sized calibre, to the upper end of which is attached a funnel. Fluid is introduced through the funnel, and syphoned out by lowering it below the level of the stomach. Before open operations, a warm solution of boric acid should be employed as the agent for irrigating the viscus.

2. **Gastrotomy**, or opening the stomach, is required for the removal of foreign bodies from it, or from the lower end of the œsophagus, for exploratory purposes, and as a means of dilating simple strictures of either the pyloric or cardiac orifices (Loreta's operation). It has also been employed with advantage for the removal of masses of cancerous disease by curetting.

Operation.—When a foreign body can be distinctly felt within the viscus, any incision that seems to promise ready access may be employed; but it is generally made on the left side, parallel to, and about a finger's breadth from, the edge of the costal cartilages, and about 2½ inches in length (Fig. 286, A). The position of the left lobe of the liver must be previously ascertained by percussion, and the centre of the incision is best placed about ¾ inch below it. The abdominal wall is completely divided, and the peritoneum opened. The fingers are then introduced, and the stomach sought for; it is recognised by its position immediately under the liver, and by the thickness, pink colour, and opacity of its wall. If the omentum or transverse colon present in the wound, they must be pushed down, and the stomach looked for above them. The spot where the stomach is to be opened is now decided on, and two silkworm gut sutures introduced through the serous and muscular coats, so as to enable the organ to be kept against the abdominal wall, a careful packing with a known number of sponges or gauze swabs being also interposed between the viscus and the parietal peritoneum all round, so as to prevent any escape of fluid into the general peritoneal cavity. An incision is made in the long axis of the stomach, and the finger inserted. The removal of a foreign body must be undertaken with great care, so as not to inflict injury on the organ, the wound being enlarged, if necessary. It is subsequently closed by the Lembert or preferably the Czerny-Lembert suture. The stomach is now replaced in position, and all traces of blood, etc., removed, the external wound being closed in the usual way.

If the surgeon desires to reach the *cardiac orifice*, a somewhat larger opening in the parietes is needed, in order to allow of greater space for the introduction of the hand into the stomach so as to reach the orifice itself, which lies deeply just in front of the aortic opening in the diaphragm. When this is accomplished, the opening may be dilated by the fingers or by suitable dilators, and a foreign body can by this means be removed from the lower end of the œsophagus. The utmost gentleness must be observed in this proceeding, as serious symptoms may be easily caused by irritation and damage of the pneumogastric nerves, the terminations of which both pass through this opening in the diaphragm.

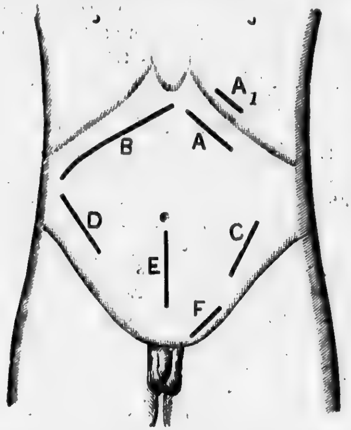


FIG. 286.—INCISIONS UTILIZED IN VARIOUS ABDOMINAL OPERATIONS.

A, Gastrotomy; A_1, additional incision in Frank's gastrostomy; B, incision for exposing gall-bladder or for pylorectomy; C, iliac colotomy; D, for appendicitis; E, median incision for ovariotomy or suprapubic cystotomy; F, for radical cure for inguinal hernia or varicocele.

The operations on the *pyloric orifice* are dealt with below.

3. **Gastrostomy** consists in the formation of a permanent artificial

opening into the stomach, through which the patient can be fed. It is called for in cases of malignant disease or intractable stenosis of the œsophagus, where the patient is exposed to the risk of starvation, owing to his inability to take nourishment.

Two chief types of operation have been recommended—viz., the old-fashioned plan, in which a direct opening is made into the viscus; and the more recent procedures, where the surgeon endeavours to establish a valvular passage.

1. *Direct Gastrostomy* is performed as follows: An incision is made, as for gastrotomy, along the border of the left costal cartilages, about 1 inch from the margin, and 2½ inches in length. The abdominal parietes are divided, the peritoneum opened, and the stomach, which is often empty and contracted, drawn up into the wound. The spot for making the artificial opening should be situated near the great convexity, and as far from the pyloric orifice as is convenient; it should be grasped by pressure forceps, or secured by a silk sling or suture, which must not, however, penetrate the mucous membrane. The stomach is then united to the parietes by a series of stitches, so as to expose a portion of the gastric wall about 1 inch in diameter. It is, of course, desirable to obtain as extensive surface contact as possible between the parietes and the viscus, and to this end a row of looped stitches is inserted all round the opening about ¾ inch from the incision through the whole thickness of the abdominal wall and through the serous and muscular coats of the stomach. A second row of superficial sutures secures the margins of the incision, bringing them into close apposition with the gastric wall. More elaborate methods of suturing have been described, but we must refer readers for details to larger text-books. The wound is dressed and left for a few days, and then a small opening is made into the stomach, and a tube inserted, through which the patient can be fed. Prior to opening the stomach, it is better to feed the patient by nutrient enemata, even if swallowing is possible, so as to avoid peristalsis of the organ, and to ensure better union. Howse recommends that the parietal incision should pass vertically through the fibres of the rectus muscle, so as to obtain a sphincter-like action.

The results of this method of operating are by no means satisfactory, especially if, as is often the case, it is performed so late that the patient succumbs from the shock. Moreover, even if successful, they often suffer great inconvenience from the prolapse of the mucous membrane, and from irritation of the skin around the opening, owing to escape of the acid gastric juice; this latter condition is best alleviated by scrupulous attention to cleanliness, and by powdering the surface with bicarbonate of soda, but in spite of every precaution the skin usually becomes digested and extensively ulcerated. Various forms of flanged tubes have been employed to overcome this difficulty, but without much success.

2. *Valvular Gastrostomy* has been introduced during the last few years so as to prevent these complications, and there can be no doubt that the improvements thus effected have been very great. Two chief methods have been suggested—viz., Witzel's and Frank's; the latter of these is, to our minds, the preferable, and the results gained thereby are so satisfactory as to warrant us in describing it in detail.

Frank's Operation.—The usual oblique incision for exposure of the stomach is first made, the viscus withdrawn and examined, and a silk sling passed through the serous and muscular coats at the site selected for the artificial opening, so that a cone-shaped portion of the wall can be drawn up into the wound (Fig. 287, A). The parietal peritoneum is then sutured all round to the base of the cone, so as to shut it off from the general serous cavity. A second incision, about 1 inch in length, is now made on the outer side of the first wound, parallel to it, and about 1½ inches from it. The bridge of skin and subcutaneous tissue between the two is separated from the subjacent structures, and the apex of the cone of gastric wall drawn under the bridge into the second wound. A small opening is then made into the viscus through the apex, in which the silk sling is located, and the mucous membrane stitched accurately to the skin in the centre of the incision. The remainder of this incision is then closed in the ordinary way, as also the first. Healing readily occurs, and thus a valvular opening is established, which passes in an angular fashion round the margin of the costal cartilages, tending to prevent regurgita-

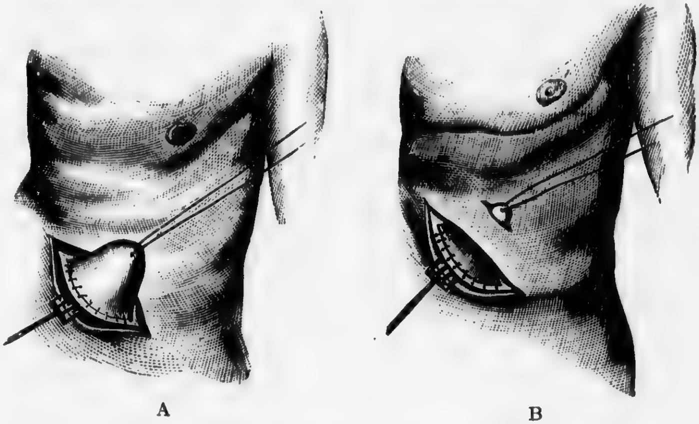


FIG. 287.—FRANK'S GASTROSTOMY.

tion of the gastric contents. The patient may be fed by the artificial opening at once. We have performed this operation of late through a vertical incision separating the fibres of the rectus, the second opening being made directly above the first; the results have been distinctly more satisfactory than with the oblique incision.

4. **Gastrectomy.**—A few cases are on record in which a limited portion of the stomach has been successfully removed for a malignant growth. The remaining portions are united by Lembert or Czerny-Lembert sutures.

Affections of the Pylorus.

Cicatricial Stenosis generally results from the healing of a gastric ulcer of the usual type, but situated at or close to the pyloric orifice; it is also sometimes due to the contraction of adhesions around an inflamed gall-bladder (cholecystitis). The effects produced are hypertrophy and dilatation of the stomach, which becomes enlarged downwards and forms a sac, in which food collects perhaps for days, and undergoes fermentative changes, being finally ejected in large quantities, mixed with frothy mucus and a yeast-like scum containing an abundance of sarcinæ. The stomach may in time almost reach the pelvis, the pylorus being dragged down with it. Succussion or splashing sounds may be heard on shaking the patient.

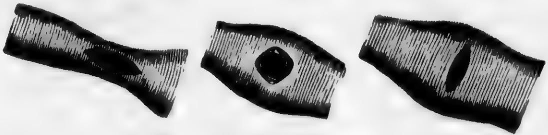


FIG. 288.—PYLOROPLASTY.

The contracted bowel is divided longitudinally, and the aperture thus made opened out, so that it can be brought together tranversely.

The **Treatment** consists at first in washing out the stomach regularly, but when that fails to give relief one of the following proceedings may be undertaken. (*a*) *Loreta's Operation* consists in dilating the stenosed orifice with the finger. The viscus is opened midway between the curvatures and about 2 inches from the pylorus, and first one finger is introduced, slowly and carefully, then two, and even perhaps three; no violence is admissible, or the walls of the orifice may be torn or ruptured. The results of this procedure have been on the whole encouraging, but it is now being replaced by other more certain and satisfactory methods. (*b*) *Excision of the Pylorus* can be undertaken in suitable cases, and the results have been so much improved by the use of the Murphy button and other similar contrivances that it need not now be greatly feared (*v. infra*). (*c*) A most ingenious proceeding has also been recently practised with good success in the shape of *Pyloroplasty*, an operation with which the name of Mr. H. W. Allingham is honorably connected. It consists in exposing the pylorus and clearing it from adhesions. A longitudinal incision is then made through the stricture, and by a little careful manipulation this wound can be opened out and brought together in a transverse manner so as to greatly increase the lumen of the orifice (Fig. 288). Two rows of stitches are inserted, one through the mucous membrane, and the other through the muscular and serous coats. (*d*) Where the pylorus is so intimately adherent to adjacent structures, and so involved in cicatricial material as to render it unsafe, or even impracticable, to expose it sufficiently to allow of the above proceedings, *Gastro-enterostomy* (p. 853) must be undertaken as a last resource.

Pyloric Cancer usually occurs in the form of scirrhus, and as it involves the whole circumference of the gut, it causes great obstruction to the onward passage of its contents. The growth early extends beyond the limits of the pylorus, becoming adherent to and implicating the under surface of the liver, the head of the pancreas, colon, and even, when of large size, the anterior abdominal wall. The early symptoms consist of slight pain, followed by feelings of discomfort, dyspepsia, and nausea; but when typical, they may be grouped together as follows: 1. Those due to pyloric obstruction, viz., dilatation of the stomach, with sarcinous vomiting: 2. the intrinsic signs of the growth, viz., the existence of a tumour a little above and to the right of the umbilicus, which is at first rounded and definitely limited, except on the left side, where it shelves off into the stomach; it is moveable in the early stages, but later on becomes fixed; it is firm in consistence, and somewhat tender on manipulation and pressure, and may receive pulsation from the underlying aorta: 3. conditions arising from interference with surrounding parts, *e.g.*, jaundice and ascites from pressure on the bile-duct or portal vein respectively, whilst œdema of the legs or varicosity of the superficial abdominal veins may arise from compression of the inferior vena cava: 4. general cachexia and asthenia due partly to the cancerous growth, partly to defective nutrition. For fuller details we must refer to medical text-books.

Treatment.—If the mass is comparatively moveable and there are but few adhesions, as in the early stages, pylorectomy or removal of the diseased portion of gut may be undertaken; but where the growth has extended beyond the bowel to adjacent viscera, or where massive adhesions are present, gastro-enterostomy or the formation of an artificial communication between the stomach and intestine below the growth is alone practicable.

. *Pylorectomy* is an operation which has been performed both for simple and malignant stricture of the pylorus, but until quite recently the mortality connected therewith was so great as to render it almost a hopeless procedure. Thus, in seventy-two cases dealt with for malignant disease by the old plan of operating, fifty-five died from the immediate effects, whilst in ten cases of simple stricture only four recovered. The latest statistics of operations in which the Murphy button was employed are, however, much more encouraging. (*a*) In *Billroth's operation* the abdomen is opened by any incision which suits the exigencies of the case, though perhaps the best to employ is an oblique one 4 or 5 inches long, extending from the median line above downwards towards the right, nearly parallel to the right costal margin (Fig. 286, B). The diseased area is now explored, and a final decision made as to the practicability or not of removing it. If an operation is determined on, the growth is carefully isolated from surrounding parts by dividing the attachments of the great and lesser omenta, any enlarged glands being also enucleated. Clamps are then applied to the stomach and duodenum, and the operation area well packed round with sponges. The mass is now removed (Fig. 289) and the divided ends united (Fig. 290), but for exact details we must refer to larger text-books of operative surgery. The operation is prolonged and difficult, and profound shock is usually experienced. Carefully regulated stomach-feeding should not be too long delayed after the operation, the best results having occurred in those cases where it was started early. (*b*) When the *Murphy*

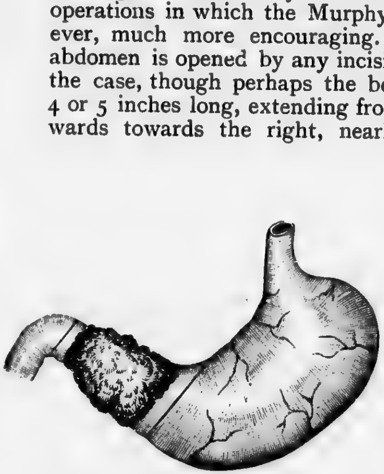


FIG. 289.—MALIGNANT GROWTH OF THE PYLORUS, AND INCISIONS IN STOMACH AND DUODENUM NEEDED FOR ITS REMOVAL. (TILLMANNS.)

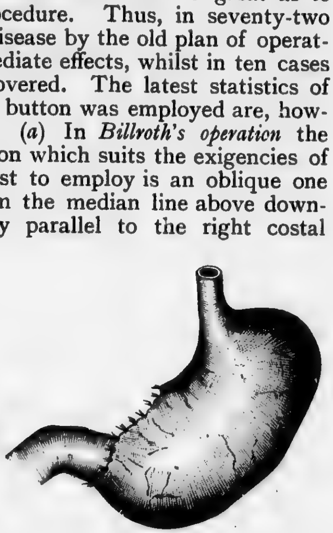


FIG. 290.—METHOD OF SUTURING THE UNEQUAL WOUNDS LEFT AFTER REMOVAL OF GROWTH. (TILLMANNS.)

The upper end of the gastric incision is closed, so as to render the openings in the stomach and duodenum of equal size.

button is employed, the same steps are followed until the growth is isolated, and then the mass is cut away at once, care being taken to leave three-quarters of an inch of sound tissue on each side. The gastric wound is then entirely closed by a row of Czerny-Lembert sutures. The heavier male end of the Murphy button is inserted into the open mouth of the duodenum, and the purse-string suture tied, as detailed below (p. 874), whilst the female half is placed in a new opening made for it in the posterior wall of the stomach, as for a lateral anastomosis (p. 876). The two halves are then united, and the operation is completed, except as far as regards the usual toilet of the peritoneum and the closure of the parietal incision.

Gastro-enterostomy (Fig. 291) may also be undertaken by simple suturing of the required viscera together (Wölfler's operation), or by the use of the Murphy button. The portion of bowel which is selected as the site of the artificial opening should be the upper part of the jejunum, since if the communication is established too low, a much greater absorbing surface is isolated, with the result that even if the operation is successful the patient gradually emaciates owing to lack of nutriment; and the rapidity of the emaciation will increase as the communication is placed further from the duodenum.

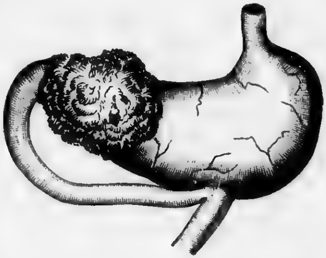


FIG. 291.—GASTRO-ENTEROSTOMY FOR MALIGNANT DISEASE OF THE PYLORUS. (TILLMANNS.)

The incision employed is usually one in the middle line through the linea alba. The stomach is readily found, and the condition of the growth examined so as to determine whether or not it is removable. Formerly it was the practice to unite the bowel to the anterior wall of the stomach, but recently the majority of surgeons have followed with advantage the plan recommended by Von Hacker of utilizing the posterior gastric wall for this purpose. It is accomplished in the following manner: The transverse colon is withdrawn from the wound, together with a portion of the omentum, the left half of the viscus being specially sought for. By tracing down the transverse meso-colon to its attachment to the posterior abdominal parietes, the termination of the duodenum is readily reached as it crosses the middle line along the lower border of the pancreas, and with the superior mesenteric vessels lying in front of it; by this means the upper portion of the jejunum is easily found, and a suitable spot for making the anastomosis selected. A hole is then made through the transverse meso-colon, so as to open into the lesser sac of the peritoneum, and enable the posterior wall of the stomach to be reached. A clamp is placed on either side of the selected portion of bowel, so as to prevent the escape of intestinal contents when the gut is opened; but, of course, it is impossible to do the same to the stomach; the latter viscus ought, therefore, to be thoroughly washed out with some dilute antiseptic, such as boric acid, before the operation commences. Sponges are also packed around the site of operation, so as to receive any fluid which may escape.

If Wölfler's plan of simply suturing is adopted, two incisions about an inch long are made, one in the stomach and the other in the jejunum, involving at first only the serous and muscular coats. In the stomach it is made parallel to the great convexity, and about 1½ inches from its lower edge, whilst in the jejunum the incision is longitudinal, and situated along the anti-mesenteric border. Both of these wounds gape to such an extent as to allow of the union of the divided coats on the lower side by the insertion of a row of fine catgut stitches. The mucous membranes are then incised, and a row of gut sutures is introduced to unite them to the same extent, the knots being located within the lumen of the bowel. The surgeon then deals with the remaining unconnected lateral and upper segments of the openings, taking up the mucous membranes and serous coats separately by a double row of stitches, the knots being placed on the outer aspect of the viscera. Thus, the deeper parts of the opening are sealed by what is known as Wölfler's suture (Fig. 296, p. 866), and the upper and more accessible portions by the Czerny-Lembert stitch (Fig. 294).

If the Murphy button is employed, one of medium size should be selected, and it is introduced according to the rules given below (p. 876) for lateral anastomosis.

The operation is completed by suturing the margins of the opening in the meso-colon to the stomach, so as to prevent any subsequent contraction, by cleansing the peritoneum, and closing the parietal incision in the usual way.

The after-treatment consists in abstaining from stomach-feeding for at least forty-eight hours, if practicable, rectal alimentation being resorted to in the interim. Not unfrequently there will be some regurgitation of bile into the stomach, and this may lead to troublesome vomiting for a few days; but if the junction is satisfactory, it soon passes off, especially when food is administered by the mouth, as may usually be undertaken on the third day. At first only fluid nourishment should be permitted, but in a week's time soft solids may be given, and gradually a more liberal diet is ordered. The effect of the operation is necessarily only palliative when cancer is present, but the general condition often improves considerably for a time, and the final exitus lethalis is associated with less suffering.

Other plans of operation have been utilized besides those described above, such as Senn's bone plates, or Maunsell's operation; but there can be no doubt that they are less satisfactory in this particular condition. In comparing Wölfler's and Murphy's methods, the great advantage of the former consists in its introducing no foreign body, which may give rise to trouble from slipping back into the stomach or from impaction lower down the gut; hence it should always be used in non-malignant cases. The proceeding is, however, much more tedious, and the shock caused by the prolonged operation is often sufficient in itself to turn the balance against a patient whose powers have been considerably diminished by a malignant growth associated with semi-starvation. Murphy's operation, though placing a solid body of some size within the intestinal canal, has the great advantage of rapidity, and, on the whole, we are inclined to recommend this proceeding as the better in malignant disease. The results hitherto obtained have been most encouraging, Murphy being able to report twenty-nine cases, with only eight deaths, and we ourselves have had several successful cases. The button, if all goes well, ought to appear in the motions about a fortnight after the operation.

Ulcer of the Duodenum is occasionally met with after burns, as already described at p. 85. It may also occur in the same way as a gastric ulcer—*i.e.*, more or less spontaneously, and without any apparent cause. The symptoms to which it gives rise are deep pain in the right hypochondrium, worse after food, together with vomiting. Hæmorrhage may be caused by the ulcer laying open some branch of one of the pancreatico-duodenal vessels, and this may prove fatal. Perforation is sometimes induced, and, according to its situation and size, it gives rise to acute or chronic suppurative peritonitis, or if it opens posteriorly to a subphrenic pyo-pneumothorax, which tends, however, to come to the surface to the right of the suspensory ligament of the liver; in fact, the symptoms and results are very similar to those of perforating gastric ulcer (*q.v.*). Stenosis of the duodenum may also follow this lesion, and the same type of treatment must be adopted as in gastric ulcer and its complications.

Affections of the Intestine.

Congenital Conditions are occasionally met with affecting the intestines, and perhaps giving rise to serious complications. (*a*) The most common of these consists in what is known as *Meckel's diverticulum*. It occurs as an outgrowth from the lower end of the ileum, which may be patent for 1 or 2 inches, terminating possibly in a fibrous cord, which floats free amongst the intestines, or may contract adhesions, and thus determine an internal strangulation; or it persists as an open tube as far as the umbilicus, giving rise to a congenital fæcal fistula. It is due to non-obliteration of the omphalo-mesenteric duct. (*b*) *Congenital stenosis* of the duodenum also occurs opposite the entrance to the common bile-duct, and a similar condition may arise in the lower part of the ileum at a spot from which Meckel's diverticulum is usually developed.

Injuries of the Intestine.

Contusion of the Intestine may result from any serious blow on the abdomen, and necessarily varies in its effects with the nature and force of the injury, the amount of distension of the gut, and the strength and power of resistance of the parietes. In its simplest form, it merely produces a little bruising of the intestinal wall, followed by a subacute or chronic enteritis, from which with care the patient will quickly recover. In the more severe cases, an acute enteritis ensues due to bacillary invasion, which may even run on to ulceration or sloughing of the coats of the bowel. The latter result is more likely to follow if the mesentery has also been involved in the injury so as to produce thrombosis of the mesenteric vessels. Under these circumstances, the final issue depends largely upon the rapidity of the inflammatory process. If adhesions have had time to form between the parietes and the injured gut, the mischief is limited, and the patient may recover with an artificial anus or fæcal fistula, the formation of which has been preceded by a localized intraperitoneal abscess, containing extremely offensive pus, owing to the presence of the *Bac. coli*, which has migrated through the intestinal wall. If, however, the inflammatory affection is rapid in its onset, and adhesions have not had time to develop, acute diffuse peritonitis is almost certain to follow. When the injured portion of bowel is retroperitoneal, as in the duodenum or colon, a retroperitoneal abscess may form.

The **Symptoms** of intestinal contusion consist primarily of shock and pain. The amount of shock varies necessarily with the severity of the injury and the nervous susceptibility of the patient. The pain may not be severe during the period of shock, but is always very marked subsequently, and increased by examination, movement, or during violent respiratory efforts. To limit such movement, the abdominal parietes are maintained in a state of firm contraction, and can be felt hard and resistant. Vomiting may be present, but, as a rule, is not a marked feature. The later symptoms will necessarily vary with the course taken by the case, and need not be described in further detail.

The **Treatment** of these injuries is conducted along the same lines as that of contusions of the abdominal wall (p. 833), viz., where there is no absolute evidence of rupture, an expectant attitude must be adopted. If, however, at the end of twenty-four or forty-eight hours signs of peritonitis manifest themselves, an exploratory laparotomy is justifiable. Acute enteritis induces diarrhœa and the passage of blood-stained mucus, and such symptoms will indicate the use of bismuth, and perhaps a little morphia, whilst a fluid diet is alone permissible.

Rupture of the Intestine is a consequence of abdominal injuries of a more severe character than those causing contusion, such as when a cart or cab has traversed the abdomen, or when the patient has been tightly squeezed. The amount of distension of the gut is a most important factor in the ætiology, since it is obvious that a distended coil is much more likely to give way than one that is empty; in the latter case it is quite possible for only a small wound to occur, through which the intestinal contents are unable to escape. The bowel does not always give way at the point of impact, but occasionally at a distance from it; under these circumstances the tear is more likely to be ragged and irregular, whilst if it yields at the point struck, it may be cleanly torn across. The parts most frequently affected by this form of injury are the junction of the moveable jejunum with the fixed duodenum, and the lower 3 feet of the ileum. In this condition also the effect of the accident on the mesentery is of importance, since in the first place it may give rise to considerable intraperitoneal hæmorrhage, and later on may cause sloughing of the gut as a result of thrombosis.

The **Effects** of rupture of the intestine are always extremely serious, since acute diffuse peritonitis is almost certain to follow; in a few cases a localized intraperitoneal abscess has been known to result, but such is by no means common.

The **Symptoms** consist of severe and usually lasting shock, accompanied by intense abdominal pain. Owing to the escape of the intestinal contents, a virulent form of acute peritonitis follows immediately, from which the patient rapidly succumbs. Free gas is met with in the peritoneal cavity, as in rupture of the stomach, and may be recognised by the existence of a resonant note on percussion in front of the liver. In a few cases emphysema of the abdominal walls has been caused, and in the absence of thoracic injuries or of diffuse cellulitis is an absolutely certain sign of rupture of the intestinal tube. Vomiting occurs, but is not a marked feature in these cases; if blood is found in the vomit, it suggests that either the stomach or upper part of the intestinal canal has been injured. Occasionally a blood-stained motion is passed, but only as a late phenomenon.

The **Diagnosis** of a rupture of the intestine is always a matter of uncertainty in the absence of such symptoms as resonance in front of the liver or emphysema of the abdominal walls. The amount of shock is an uncertain guide, although if prolonged and severe, it is suggestive; whilst the incidence of early acute peritonitis is probably the only sign that we can depend upon with any certainty. The history and nature of the accident are important, and should be carefully investigated.

In the non-existence of any distinct signs of rupture, **Treatment** in the early stages can only be expectant, and directed towards combating the shock and relieving the pain. A small dose of opium should be administered with this object, and also to check peristalsis, and hinder further extravasation of the intestinal contents; but as little as possible should be given, since it tends to mask symptoms. If the surgeon has good grounds for suspecting that the intestine is torn, he ought at once to undertake an exploratory laparotomy, which in careful hands will do less harm to the patient than waiting for the onset of acute peritonitis to make the diagnosis certain. If severe shock is present, an injection of hot saline solution into a vein will sufficiently restore the patient in the majority of cases to warrant such a procedure. When a rupture is found, the same rules of treatment should be followed as those which have been enunciated for a ruptured stomach.

In **Punctures or Stabs** involving the intestine, the results differ considerably according to the amount of distension of the bowel, as also with the fluidity of the fæces and the direction of the incision. Thus, a longitudinal cut (running parallel to the axis of the bowel) is more likely to gape than a transverse one, owing to the greater power of the circular muscle fibres; a small puncture may be almost closed by a protrusion of mucous membrane. Wounds of the small intestine are more likely to be accompanied with extravasation than when the colon is involved, owing to the contents of the former being in a much more liquid state.

The **Symptoms** are very similar to those already detailed as characteristic of rupture of the intestine. As far as regards the immediate phenomena, there is nothing absolutely typical unless gas or fæcal material is escaping either from the abdominal wound or from a prolapsed portion of bowel. Shock is not necessarily so severe as when the intestine is ruptured by violence without penetration; abdominal pain is always present, and the phenomena of acute peritonitis quickly follow. In doubtful cases it has been suggested by Senn that the gut should be inflated with hydrogen gas from the rectum, and its escape from the abdominal wound would then determine the diagnosis. There is, however, a very distinct objection to such a proceeding, viz., that the resulting inflation of the bowel would be likely to open up any small puncture or incision which had occurred, and thus might determine fæcal extravasation.

We have already alluded to the line of **Treatment** which at the present day ought to be adopted in penetrating wounds of the abdomen (p. 835). Every such case should be carefully and thoroughly explored; a probe is first passed, and then the abdominal parietes divided on either side of the probe, so as to enable the extent of the mischief to be ascertained. If the peritoneum is not opened, no harm has been done, since after purification the different layers of the wall are sutured together. If the peritoneum has been involved, the opening in it should be enlarged, so as to explore the viscera and determine with certainty whether the gut has been wounded. If a small punctured or incised wound is present, it may be closed by a purse-string stitch or by a row of Lembert or Czerny-Lembert sutures. If a more extensive lesion exists, excision of the damaged portion may be necessary; but if the patient is deeply collapsed from the supervention of peritonitis, it may be wiser to bring the divided ends to the abdominal wall, and form a temporary artificial anus, which is subsequently closed when the patient's general condition has improved. As to the treatment of the resulting peritonitis, we must refer to what has been written concerning rupture of the stomach (p. 842).

Gunshot Wounds necessarily vary considerably in severity, according to the rate and size of the bullet, and the course taken by it. The aperture of entry may be very small, and, owing to the irregular contraction of the muscular walls of the abdomen, it is often impossible to pass a probe along the track. The bullet usually travels in a straight line from the aperture of entry towards the point where it escapes from the abdomen, or where it becomes lodged in one of the more solid viscera or in the parietes. The coils of gut lying immediately beneath the entrance aperture are most severely damaged, but other adjacent coils may also be involved; hence it is not unusual to find a number of wounds in the gut close together.

The **Symptoms** caused by a gunshot injury differ in no particulars from those resulting from any other penetrating wound of the bowel, and the **Treatment** to be adopted must follow along the same lines as those already indicated. The wound should be carefully enlarged, and a thorough exploration of the gut made, so that no damaged coil may escape attention. If several openings are found scattered at a considerable distance from one another, each and all of them should be sutured in the usual way; but if a number of perforations are found close together, the whole affected coil of gut should be removed, even if it amounts to many inches, or even to one or more feet. The latter proceeding is especially necessary if there is any additional injury to the mesenteric vessels.

Impaction of Foreign Bodies.—Such an occurrence gives rise to the symptoms of acute or subacute obstruction, and the subject is discussed under that heading at p. 945.

Perforation of the Intestine arises from many different causes, such as the impaction of a foreign body, or the yielding of an intestinal ulcer, as occurs in tubercular disease or typhoid fever, or from that form of enteritis which follows strangulated hernia. We have already discussed the phenomena resulting from the perforation of an ulcer of the stomach or duodenum (pp. 844 and 855), and one special variety of appendicitis due to perforation of the appendix will be alluded to subsequently (p. 885).

When the jejunum or upper portion of the ileum is involved, perforation is usually due to the impaction of a foreign body, such as a fish-bone, or to yielding of a tubercular ulcer. In acute cases, general peritonitis is almost certain to follow, and what we have written as to the results and treatment of such a lesion in the stomach applies with equal force here. Occasionally the lesion is of a more chronic type, especially when due to tubercle, and then adhesions may form, allowing an intraperitoneal abscess to develop, and should it open externally, a fæcal fistula follows. In not a few cases the process of cicatrization may lead to a spontaneous closure of the fistula, and no operation should be undertaken until sufficient time has elapsed to determine whether or not this will occur. A similar condition sometimes results from tubercular peritonitis, the umbilicus being a common site for such a fistula to develop. In other cases several coils of intestine may be matted together by adhesions, amongst which an abscess forms, which by opening into the bowel in two or more places gives rise to a fistulous communication, known as a *fistula bimucosa*.

In the lower portion of the ileum, *typhoid fever* is the most usual cause of perforation of the intestine. It generally occurs about the end of the second or in the third week of the disease, and rarely more than one perforation is present. The symptoms are usually those of sudden collapse, as indicated by a falling temperature and a quick and feeble pulse, whilst severe abdominal pain followed by distension indicates the development of general peritonitis. Even when the patient is already collapsed by the disease, some slight fall of temperature with acceleration of the pulse may occur, followed by abdominal pain and meteorism. The only *treatment* which holds out any prospect of saving the patient is operation, but owing to the depressed condition of the individual the outlook is not particularly bright. Obviously, when the patient is moribund, it is useless to interfere; but the fact that at least seven cases of recovery have been reported, out of rather more than forty that have been subjected to operation, shows that in suitable circumstances a certain percentage of success may be anticipated. The abdomen should be opened in the middle line below the umbilicus, the ileum sought for at its junction with the cæcum, and the bowel brought up and carefully examined inch by inch till the perforation is found; it may then either be closed by sutures, or stitched to the margins of the wound so as to create a temporary artificial anus. The peritoneum is cleansed and drained in the usual way.

In the large intestine the most common cause of perforation is ulceration due to chronic obstruction. Masses of fæces accumulate within the bowel, and by their pressure give rise to inflammation of the walls, which runs on either to ulceration or to actual necrosis. Most usually the peritoneum is by this means laid open, and acute perforative peritonitis follows. In malignant disease of the colon, perforation also results in some instances, giving rise to a localized abscess, and subsequently to a fæcal fistula.

Stenosis of the Intestine.

This arises from two main causes, viz., the contraction of cicatrices, and the development of malignant growths.

Cicatricial Stricture usually results from the healing of ulcers which have extended more or less circularly around the bowel. After typhoid fever they are therefore rare, since the ulcers are rather longitudinal than transverse, and, indeed, there is only one certain case of stricture arising from this source on record. In the small intestine tubercular ulceration is one of the commonest causes, since it always tends to travel around the circumference of the gut along the line of the vessels. It also arises from syphilitic disease, or as a sequela of strangulated hernia, injury, or the separation of an intussusception. In the large intestine dysentery is perhaps the most important cause of stricture, whilst syphilis or pelvic cellulitis may determine its occurrence.

Owing to the contents of the small intestine being of a somewhat liquid nature, a stricture in this situation often exists for some time before symptoms of any urgency arise. The patient may complain of a certain amount of indigestion and discomfort, but sooner or later the narrowed aperture of the gut becomes blocked either by a fold of mucous membrane or by a portion of undigested food, and thus an attack of obstruction is induced. In the early stages of the disease this can be overcome and remedied by purgatives, but each recurrence is likely to increase in severity, until finally an acute attack supervenes, which kills the patient, unless relieved by prompt surgical interference.

In the large intestine very similar phenomena appear, but the attacks of obstruction are of a somewhat different character, since there is less pain and vomiting; and aperients, instead of relieving the patient, as they often will in the earlier attacks in the small gut, always aggravate the symptoms; there is also a great deal more distension of the abdomen. The diagnosis of stricture, though strongly suggested by the nature of the symptoms, can only be absolutely confirmed by an exploratory operation, except when the lower part of the rectum is involved.

The **Treatment** in the earlier stages consists of suitable dieting, and the administration of purgatives, or of large enemata, and for a time such will be successful. Sooner or later, however, a more than usually serious attack of obstruction will call for something more radical, and we must refer readers to the chapter on obstruction for details of the treatment to be adopted (p. 950). If on operating the stricture is found and recognised, enteroplasty or excision, followed by enterorrhaphy, should be undertaken, if the small gut is involved. For stricture of the cæcum or ascending colon, some short-circuiting method, whereby the ileum is implanted into the colon below the stricture (ileo-colostomy), is perhaps the best plan to adopt; in the transverse colon excision is possible, as also in the sigmoid flexure, whilst in the descending colon enteroplasty may be undertaken. Failing any of these radical measures, the establishment of an artificial anus in the bowel above the stenosis suffices to give relief. It must be remembered, however, that no permanent opening can be made more than a foot above the ileo-cæcal valve, since the absorption of nutrition is thereby so interfered with that death from asthenia is certain to follow in a very short time.

Cancer of the Bowel is almost always primary in nature, and is then usually a columnar carcinoma, to which colloid degeneration is sometimes added. Secondary growths are occasionally met with, and are necessarily of the same nature as the original growth. The disease may occur as a localized plaque imbedded in the mucous membrane, and undergoing the usual ulcerative changes; but more frequently it appears as a circular infiltration of the bowel. Secondary deposits arise after a time in the mesenteric glands, the liver, or even in distant parts; the general history of these growths suggests, however, that they are not so malignant in type as cancer elsewhere. At first they merely give rise to dyspeptic **Symptoms** of varying character, according to the size and situation of the mass, and then to these may be superadded intermittent attacks of chronic or subacute obstruction, which originally come under the care of the physician, but at length the surgeon's assistance is needed to relieve or deal with an acute attack. Two other manifestations of the disease may determine surgical action, viz.: (1) The existence of a tumour, which, though at first readily moveable, soon becomes fixed owing to the formation of adhesions to surrounding tissues; and (2) the development of an abscess due to the invasion of the growth by the *Bac. coli*, which finds its way through the ulcerated surface of the tumour. This complication is most likely to occur when the colon is affected, and all the manifestations of an acute or subacute intraperitoneal abscess supervene. In favourable cases it bursts externally, or is opened, giving exit to exceedingly offensive pus, and for a while the patient's symptoms are relieved; a fæcal fistula is likely to follow, and the disease runs a rapid course to its inevitably fatal issue.

Treatment.—Whenever a diagnosis of malignant disease of the bowel has been made or is suspected, an exploratory laparotomy is justifiable in order to confirm or disprove the fact. Unfortunately, physicians are only too liable to leave the case until the progress of the disease has settled the question, and then palliative treatment may alone be possible. If found early enough, the growth, together with a good margin of healthy tissue on either side, should be removed, and the intestinal canal restored by enterorrhaphy. A V-shaped portion of the mesentery is included in the part excised, so as to remove if possible any affected lymphatic glands. Should this be impracticable owing to the extent or fixity of the growth, the following plans of treatment may be considered, and that which best suits the requirements of the particular case undertaken:

1. The growth may be *short-circuited* by uniting portions of gut above and below the growth. This is usually accomplished by one of the forms of lateral anastomosis described hereafter; thus, the cæcum may be attached to the sigmoid flexure in a case of cancer of the transverse colon.

2. The bowel may be entirely divided above the growth, and the upper end implanted into the gut below it, the open end of the divided bowel being sutured. This *lateral implantation* is the best plan of treatment to employ for cancer of the cæcum which cannot be extirpated; the ileum is divided above the valve, and its open end implanted into the ascending colon well above the growth (ileo-colostomy), whilst the lower end is totally closed.

3. The affected coil of gut has been *excluded* from the intestinal tube by dividing the bowel above and below, and uniting the divided ends, whilst the open ends of the diseased coil are either entirely closed by sutures, or one end is closed and the other is brought to the surface, and fixed there so as to establish a fistulous track. The latter practice is probably the safer to adopt, since there is always a certain amount of discharge from the cancerous growth, and, at any rate, in the small intestine the mucous membrane itself secretes, so that total closure would be accompanied by danger.

4. Finally, if none of these measures are applicable, or if the patient's condition is such as to make it unwise to attempt them, and if the growth is situated in the colon, an artificial anus may be established.

Operations on the Intestines.

Before describing in detail the actual operations which are undertaken upon the small or large intestine, it is essential that the various **Sutures** employed in such work should be discussed. The interior of the bowel is occupied by material which, as long as it remains in its proper place, is innocuous enough; but let it once find its way into the peritoneal cavity, an acute and usually fatal peritonitis is almost certain to follow. Hence, every union made by the surgeon must be air- and water-tight, and capable of accommodating itself to varying degrees of intra-intestinal pressure. For this reason a continuous stitch must never be employed except in the long axis of the bowel, or unless there is some button or bobbin within it. Again, it is essential that along the line of union nothing but serous membrane should be exposed, as otherwise adhesions are certain to form, and the comfortable action of the bowel will be subsequently impaired. Hence, special forms of stitches have to be adopted, the more important of which are described below.

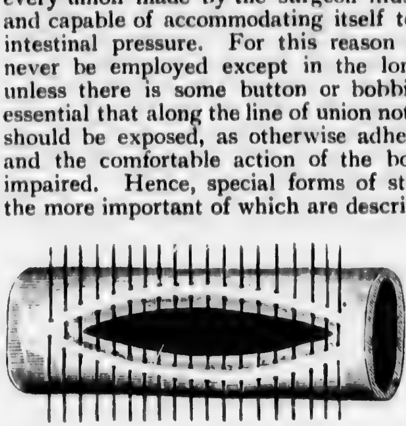


Fig. 292.—Lembert's Suture as applied for a Longitudinal Wound of the Bowel.

The stitches are carried well beyond the extremities of the incision, so as to obliterate the groove always caused by this method of suturing.

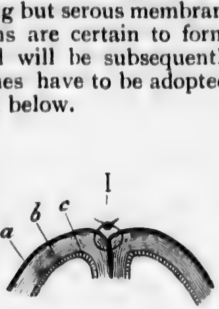


Fig. 293.—Lembert's Suture seen in Section, to show Character of Approximation.

I., Suture; *a*, serosa; *b*, muscularis; *c*, mucosa.

Lembert's Suture, originally proposed at the end of last century, has for its object the bringing of surfaces of peritoneum together without encroaching on the mucous membrane; any stitch which involves the whole thickness of the wall is liable to be followed by leakage of the intestinal contents, and possibly peritonitis. The needle is passed at right angles to the axis of the wound through a small fold of the serous and muscular coats, going down to the submucosa; each fold is placed about one-twelfth of an inch from the margins of the incision (Fig. 292). On drawing up and tightening the stitch, the margins of the wound are tucked in (Fig. 293), and only serous coats brought into apposition. A series of similar stitches are inserted along the whole extent of the wound, numbering about ten or twelve to the inch. In closing a longitudinal incision in this way, a groove will be formed at either end which must be obliterated by two or three extra sutures. For a small puncture the same type of stitch may be utilized, but it may be introduced circularly around the opening like a purse-string, and by tightening it the margins of the aperture are turned in and buried.

The *Czerny-Lembert Suture* is very similar in its nature, but consists of two rows: the first has for its object the closure of the wound in the mucous membrane (Fig. 294, I), and in a longitudinal wound this may be of the continuous type; the second row consists of the ordinary Lembert stitches, continued or interrupted according to the requirements of the case (Fig. 294, II). By this means the knots of the first series of sutures are covered over and buried by the second row.

Halsted's Suture (Fig. 295) is a very valuable one, which has been a good deal utilized of late. It consists practically of a double Lembert, a loop being thus formed at one end, whilst the knot is tied at the other. It is introduced with exactly the same precautions as the original Lembert.

Occasionally it happens that two portions of bowel have to be stitched together, although the surgeon cannot reach the outer coats owing to this portion being fixed. Thus, in dealing with the posterior segments of the walls of the bowel, either in pylorectomy or gastro-enterostomy, it is found that one can only work from the front, and the stitches must then be inserted by what is known as *Wölfler's Method* (Fig. 296). The sutures are first passed through the serous and muscular coats on either side (I.), the knots being tied on the inner aspect—*i.e.*, towards the lumen of the open gut. The mucous membrane is then secured by a second row of stitches (II.), so as to cover over the first series of knots. Of course, only a portion of the circumference of the bowel has to be dealt with in this way; as soon as possible, one changes to the Czerny-Lembert method.

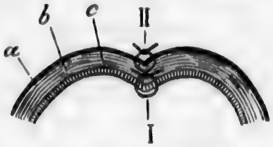


FIG. 294.—CZERNY-LEMBERT SUTURE.

I., Stitch securing divided mucous membrane; II., ordinary Lembert suture for the serous coats; *a*, serosa; *b*, muscularis; *c*, mucosa.

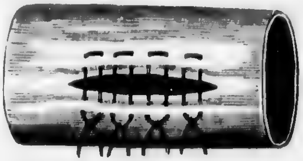


FIG. 295.—HALSTED'S SUTURE.

Passing on now to the actual operations, the following have to be described:

1. **Enterotomy** is a term which is only correctly applied to an incision made into the intestine either for the removal of a foreign body or for the examination of the interior of the intestine. The wound should always be made in the longitudinal axis of the gut,

and along its anti-mesenteric border; it is closed by a row of Lembert, Czerny-Lembert, or Halsted stitches.

The same title, enterotomy, has, however, been often incorrectly employed to denote the operation which is sometimes undertaken for the relief of intestinal obstruction when the patient is almost moribund, and one is unable to make an exact diagnosis of the cause. It is especially useful when the obstruction is probably due to some lesion located in the cæcum or ascending colon. An incision is made, either in the middle line or in the iliac region on the right side, somewhat similar to that employed for removal of the appendix; the first distended coil which presents is drawn well out, and opened after carefully protecting the peritoneal cavity from fæcal infection with sponges. It is allowed to empty itself, and is then fixed to the parietes, and a Paul's tube tied in (Fig. 297), so as to carry away the intestinal contents clear from the wound. This proceeding is often known as Nelaton's operation, but should in reality be termed *Enterostomy*.

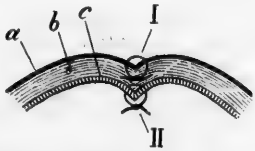


FIG. 296.—WÖLFLER'S SUTURE.

I., Stitch through serous and muscular coats applied and tied from within; II., stitch uniting divided mucous membrane over the former, so as to cover it in; *a*, serosa; *b*, muscularis; *c*, mucosa.

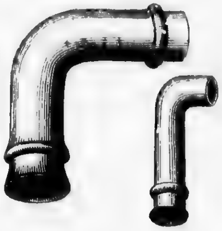


FIG. 297.—PAUL'S TUBES, SMALL AND LARGE SIZES.

2. **Enteroplasty** is a plan of treatment which has been devised for dealing with cicatricial strictures of the intestine, and is based on the same idea as the operation of pyloroplasty for fibrous stenosis of the pylorus (p. 850). A longitudinal incision is made through the stenosed gut along the anti-mesenteric border; this is opened out, and converted into a transverse cleft, which is then carefully sutured, the lumen of the bowel being thereby considerably increased (Fig. 288).

3. **Enterectomy**, or excision of a portion of the bowel, is called for in the following conditions: (*a*) For the removal of gangrenous gut after strangulation, whether internal or external; (*b*) in the treatment of multiple penetrating wounds, as after a stab or gunshot injury; (*c*) in dealing with artificial anus; (*d*) for the removal of simple or malignant strictures; and (*e*) in some cases of intussusception. Not long ago the operation was but rarely undertaken, and the results were most unsatisfactory; but at the

present time a very considerable degree of success may be expected, and enterectomy is frequently practised. Naturally, the results vary largely with the condition for which it is performed, and with the experience and skill of the operator; a much higher rate of mortality follows when the excision is done for malignant disease, for gangrene following strangulation, or for intussusception, than when performed for other causes.

Whenever practicable, the bowel should be thoroughly emptied prior to operation, and rendered as sterile as possible by the use of such drugs as calomel (gr. i. daily), salol, β-naphthol, bismuth subnitrate, etc., for a few days previously. The abdomen is opened by any suitable incision, and the portion to be removed clearly defined, the general peritoneal cavity being protected by a careful packing with sponges or gauze.

The bowel must then be carefully *clamped* on either side of the seat of operation, so as to prevent the escape of intestinal secretions or fæces. Any of the forms of clamps figured in surgical instrument catalogues will effect this purpose, and amongst the best are Makins' or Lane's. If, however, the surgeon should have to operate without the aid of these, the same result is easily attained by passing a piece of drainage-tube through the mesenteric attachment, and tying or clamping it around the gut.

The affected portion is now removed by scissors, cutting through the bowel and taking away a V-shaped portion of the mesentery, after securing as far back as possible the main nutrient vessels to the diseased area, according to Murphy's recommendation. It must be remembered that the terminal vessels run circularly round the gut, and have but little lateral anastomosis, and therefore it is essential not to encroach too freely on the mesenteric attachment, otherwise the projecting edge of the anti-mesenteric border is certain to slough, and septic peritonitis to result. Some operators recommend that the mesentery should not be cut into, but that the gut should be detached from the mesenteric junction; such practice will suffice when merely a small segment of bowel is to be removed; but if a large portion needs resection, it would take a much longer time to secure all the bleeding-spots. The wound in the mesentery is subsequently secured by sutures, and the divided ends of the bowel united by one of the many forms of enterorrhaphy described below.

4. **Enterorrhaphy** is called for in any condition in which there is a solution of continuity of the canal, and necessarily the methods employed must vary according to the character and situation of the lesion. We have already alluded to the plans that are utilized in dealing with longitudinal wounds of the gut. The two chief methods that remain to be discussed are the end-to-end union of a totally divided segment of the bowel, and the means whereby lateral approximation or union is secured.

For **end-to-end union** the following are the chief methods that have been adopted:

A. Enterorrhaphy by *simple suturing*. In this the surgeon utilizes no special apparatus, but trusts to the deftness of his fingers and the accuracy of his stitches. The gut is united by a series of interrupted Lembert or Czerny-Lembert sutures, inserted around the circumference at distances of about one-twelfth of an inch. The greatest care must be employed in dealing with the mesenteric attachment, where the peritoneal layers separate in order to enclose the bowel, and where there is a considerable likelihood of the muscular coat being missed; if this happens leakage is almost certain to ensue. This method in skilled hands is very satisfactory in its results, but there is one great objection to it, viz., the time taken in its performance.

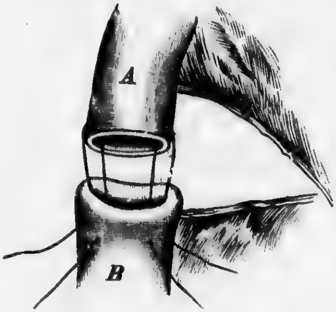


FIG. 298.—JOBERT'S METHOD OF ENTERORRHAPHY BY INVAGINATION. (TILLMANNS.)

The upper end, A, is carried into the tucked-over lower end, B, by means of the sutures, which pass through all the coats of each.

B. Enterorrhaphy by *invagination* of one end into the other includes Jobert's method, Senn's modification of Jobert, and Maunsell's operation, the invagination in the latter case being merely of a temporary character.

In *Jobert's Operation* (Fig. 298) the upper end of the bowel, A, is tucked into the doubled-over lower end, B, by means of sutures passed through the whole thickness of the intestinal walls. A row of Lembert's sutures subsequently completes the fixation of the bowel. It is a troublesome method to accomplish satisfactorily, and the transfixion of the whole thickness of the gut is not advisable, unless there is some other great compensatory advantage.

In *Senn's Modification* of Jobert's method, a circular ring of india-rubber is stitched within the divided upper end, so as to make it more rigid, and facilitate the invagination.

Maunsell's Operation is perhaps the best plan of end-to-end enterorrhaphy that has yet been suggested. It may be described in stages as follows: (*a*) Two long horsehair sutures are passed through the whole thickness of the mesenteric and anti-mesenteric borders of each end of the divided intestine, which are thus temporarily approximated (Fig. 299). (*b*) A longitudinal incision about three-quarters of an inch in length (Fig. 299, A) is then made through the anti-mesenteric border of the bowel, about an inch from the end of the upper or lower segment, according to convenience. (*c*) The horsehair sutures (Fig. 300, D) are now passed within the intestine, and drawn out of the lateral opening.

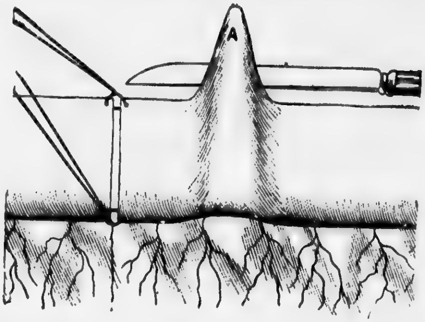


FIG. 299.—MAUNSELL'S OPERATION FOR UNITING DIVIDED SEGMENTS OF GUT.

The mesenteric and anti-mesenteric traction stitches have been introduced, and A shows the situation of the lateral incision, and its formation by transfixion.

Traction upon these, assisted by a little careful manipulation, enables the surgeon to produce an artificial intussusception (Fig. 301). The divided ends of the bowel will now present through the lateral aperture as two tubes one within the other (Fig. 302), their serous coats being in contact, and the mucous coats lining both the inner and outer aspects of the protrusion. (*d*) A sharp straight needle (Fig. 302 A), carrying after it a thread

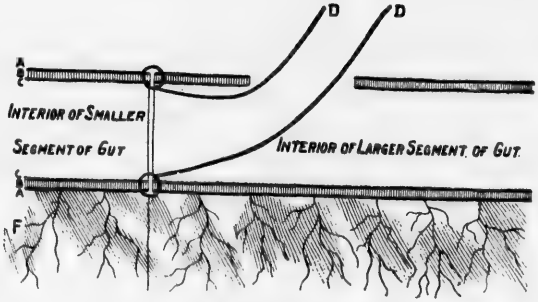

D
D
A
B
C
INTERIOR OF SMALLER SEGMENT OF GUT
INTERIOR OF LARGER SEGMENT OF GUT
C
B
A
F

FIG. 300.—MAUNSELL'S OPERATION.

D, D, Traction stitches carried through the tube, and out of the lateral opening; A, serosa; B, muscularis; C, mucosa; F, mesentery.

of fine silk or catgut, is passed through one of the diameters of the protrusion, transfixing the serous, muscular, and mucous coats. The central portion of the suture as it passes across the inner tube is drawn out and divided, and the two halves are tied on either side. Similar sutures are passed in other diameters, until some sixteen or more are present. By this means the two tubes are securely united together. (*e*) All the sutures are cut short, and the intussusception reduced. The bowel will be found accurately sutured (Fig. 303), the knots of all the stitches being placed within the lumen of the gut. (*f*) The lateral opening in

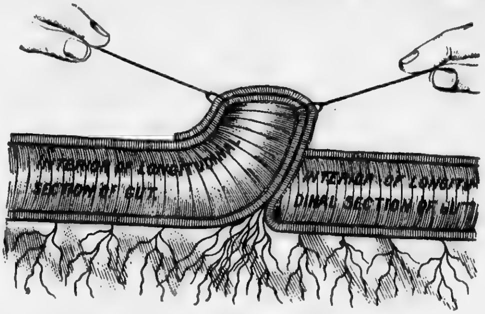


FIG. 301.—MAUNSELL'S OPERATION, SHOWING POSITION OF INTESTINE AFTER INVAGINATION HAS BEEN ACCOMPLISHED.

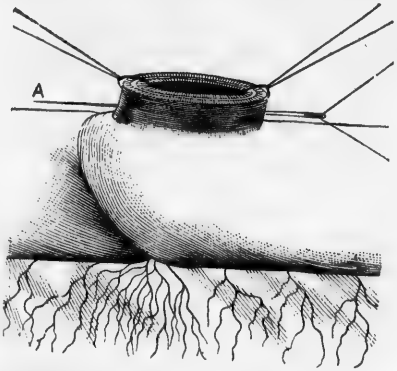


FIG. 302.—METHOD OF INSERTING STITCHES IN INTESTINE IN MAUNSELL'S OPERATION.

A shows the needle passed through both sides of the bowel, and through all the intestinal coats, so that one passage of the needle places two sutures.

the gut (Fig. 303, B) is closed by a continuous row of Lembert's sutures, and if need be a row of the same may be inserted around the circular junction, as an additional safeguard in order to bury the penetrating stitches, and so prevent leakage. The operation can be rapidly performed, and gives excellent results.

Should it be necessary to unite unequal portions of intestine, the larger segment is first reduced in size by the insertion of a row of Lembert's or Czerny-Lembert's sutures, so as to make the opening correspond in size to that of the smaller; invagination may then be accomplished through a lateral opening in the larger portion, and the operation completed as before.

A modification of this method has been recently suggested and practised with success by Ullman. After the invagination through the lateral incision has been accomplished, a hollow bobbin made of decalcified bone or carrot, and with a circular groove around its middle, is inserted into the inner canal, lined by mucous membrane. Around this the two tubes of gut are firmly tied by a single silk thread. The bowel is now retracted, carrying the bobbin in its grasp, and the operation is completed by closing the lateral opening. The bobbin retains its shape and texture sufficiently long to enable the segments of the intestine to become firmly united by plastic lymph. If further use confirms Ullman's experiences we shall have in this method a most valuable addition to our means of obtaining rapid and secure end-to-end union.

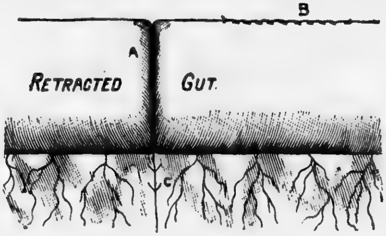


FIG. 303.—MAUNSELL'S OPERATION COMPLETED AFTER THE INVAGINATION HAS BEEN REDUCED.

A shows line of union with serous coats turned well in, so that none of the sutures appear outside; B, longitudinal incision stitched up; C, wound in the mesentery secured by sutures.

C. Enterorrhaphy by the use of *special apparatus*. Under this heading various bobbins and Murphy's button must be included.

Murphy's Button is represented in Fig. 304. It consists of two portions, a male and a female, which can be easily insinuated one into the other and closed, but which can only be separated by untwisting, the spring catches seen in the side of the stem of the male working along a screw thread in the interior of the female. Each half consists of a central stem, which is hollow for the passage of fæces when *in situ*, to the outer end of which is attached a cup-shaped expansion. In the male half there is an additional inner cup or flange, separated from the former by a spring, so that when the two halves are approximated, the inner cup is kept constantly pressed against the female half, and thus pressure-atrophy of the tissues grasped between the two segments results, ultimately setting the button free. In the meantime, however, a sufficient formation of lymph will have occurred along the line of junction of the two to prevent extravasation and to secure union.

In performing end-to-end anastomosis, a running thread is inserted through each end of the divided intestine in the manner shown in Fig. 305. It commences at the anti-mesenteric border (*b*), and traverses the whole thickness of the gut two or three times until it reaches the mesentery (*a*), when a return overstitch is introduced so as to gather without fail the two layers of the mesentery into the grasp of the button. The same stitch is continued along the opposite side of the tube, and brought out again at the anti-mesenteric border. A half-button is now introduced into each end of the divided gut, and preferably the heavier male end into the lower segment; the stitch is then drawn tight and tied, so as to gather up the gut wall round the central stem of the button (Fig. 306). The two halves are now pressed together (Fig. 309), sufficient force being employed to bring the walls of the gut into accurate apposition, but without exercising injurious pressure.

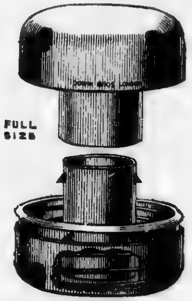


FIG. 304.—MURPHY'S BUTTON. (DOWN BROTHERS.)

A portion of the cup of the male half has been cut away so as to expose within it the spring by means of which the inner cup or flange is governed.

The button is generally set free about the seventh day, and should pass downwards, and be expelled with the fæces any time from the fourteenth to the twenty-first day. Occasionally there are difficulties in the onward passage of the button, which may either be retained entirely, or may become impacted; under these circumstances it has been known to ulcerate through the walls of the gut, and cause a fatal peritonitis. The results of the operations undertaken by means of the button are most satisfactory, compared with the old statistics; but it is doubtful whether they are any better than those obtained by many of the methods introduced more recently. The one great advantage of this appliance is the rapidity with which the anastomosis is completed. There are, however, several very grave objections to its employment as a routine measure; the fact of its being made of metal is of itself a drawback, and fatal issues have certainly occurred from sloughing, from want of union due to the use of too large a button, or of one badly constructed, and even from subsequent obstruction and perforation when it has passed lower down. On the whole, one would be inclined to use it when time is of value, and the patient's general condition such as necessitates the utmost speed in operating; under other circumstances one would prefer Maunsell's operation for end-to-end anastomosis when practicable.

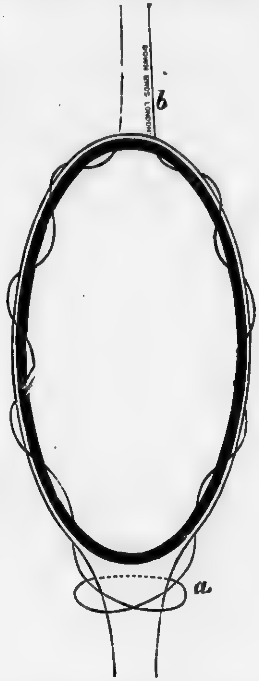


FIG. 305.—METHOD OF INSERTING SUTURE FOR END-TO-END ANASTOMOSIS WITH MURPHY'S BUTTON.

a, Mesenteric attachment and overstitch; *b*, anti-mesenteric border and two ends of suture.

Another useful contrivance is *Mayo Robson's Bobbin.* This consists of a hollow tube of decalcified bone shaped as seen in the illustration (Fig. 307), and made of different sizes to fit the varying lumen of the gut. Its object is not so much to bring about apposition of the divided ends of the bowel as to act as an internal splint, steadying the part during and after the operation, facilitating thereby the introduction of the stitches, and shielding the line of union from the irritation of fæces for some days. A continuous stitch, either of the Lembert or Czerny-Lembert type, is utilized, and is tied sufficiently firmly upon the narrowed central portion of the bobbin to prevent it from slipping away. The material of which it is composed (decalcified bone) is such as to do no subsequent harm to the mucous membrane, since it becomes soft and pulpy in the course of a few days; the results which have been gained by its means compare most favourably with those obtained by other appliances.

5. **Lateral Anastomosis** of the intestine is usually undertaken in order to effect the short-circuiting of some malignant growth, or of a stricture which cannot otherwise be dealt with. It is sometimes employed instead of end-to-end anastomosis to unite divided segments of intestine. The open ends are first entirely closed by Lembert or Czerny-Lembert stitches, and the portions of bowel made to overlap. Corresponding lateral incisions are then made into each.

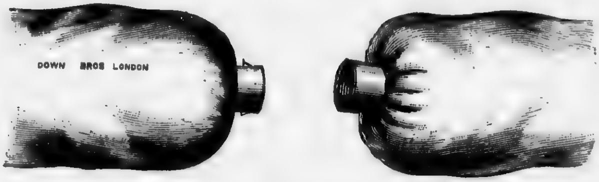


FIG. 306.—APPEARANCE OF INTESTINAL SEGMENTS WITH MURPHY'S BUTTON TIED IN. (DOWN BROTHERS.)

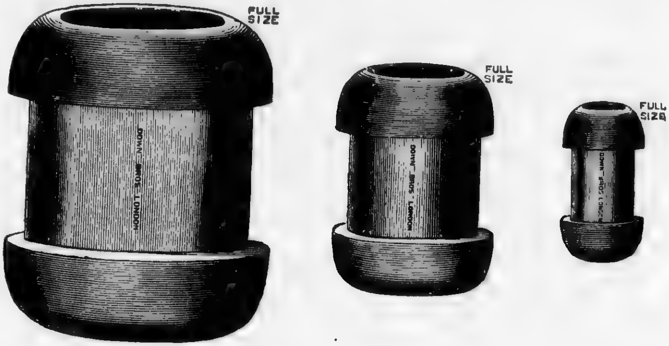


FIG. 307.—MAYO ROBSON'S BOBBIN IN VARIOUS SIZES. (DOWN BROTHERS.)

The anastomosis may be effected in one of three ways:

(*a*) By *Simple Suturing*, or, as it is sometimes called, by Wölfler's operation. This has been already described under gastro-enterostomy at p. 853. The longitudinal openings in the two portions of bowel lying exactly opposite each other are secured by sutures, inserted in the posterior half by Wölfler's plan, and in the rest of the opening by the Czerny-Lembert method. In order to prevent subsequent contraction, it is absolutely essential that the mucous membrane be continuous all round the aperture.

(*b*) *Senn's Plates* consist of oval portions of decalcified bone with a central opening, threaded with silk sutures, which pass through the substance of the plate at the ends of the longer and shorter diameters. The sutures passing through the shorter diameters have needles attached to them (Fig. 308, *a*). The portions of bowel to be united are placed opposite each other, and lateral incisions made into the lumen of each, so as to correspond in situa-

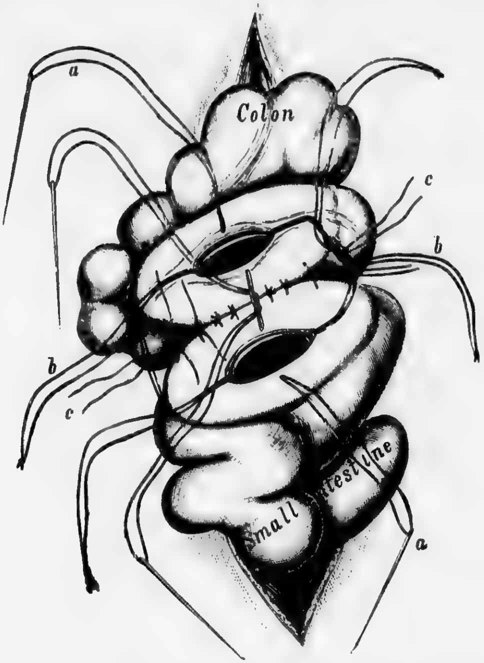


FIG. 308.—LATERAL ANASTOMOSIS BY SENN'S PLATES. (TREVES' 'OPERATIVE SURGERY.')

The plates have been inserted into the opened intestines. *a*, *a*, Sutures with needles attached, corresponding to short axes of plates, carried through the whole thickness of the gut wall; *b*, *b*, threads corresponding to long axes of plates brought through the openings; *c*, *c*, row of Lembert's sutures to isolate area of operation.

tion to each other. A bone plate is then passed through each opening into the gut. The sutures carrying needles and corresponding to the short diameter of the plate are passed through the whole thickness of the intestinal wall, whilst the unthreaded sutures (*b*) at each end of the plate pass through the opening, and thus assist in keeping it patent. The corresponding stitches are tied together, and a row of Lembert's sutures (*c*) encircle the whole. By this means intestinal anastomosis is readily effected, the bone plates being left *in situ*, and passed per anum at the end of a week or ten days. The great objection to the operation is the tendency to leakage induced by the stitches, which necessarily are rather thick, and pass through the whole thickness of the gut wall; this is increased by the difficulty of closely approximating the plates, owing to the presence of the knots between them. Owing to this and other reasons this method of operating has fallen into disuse.

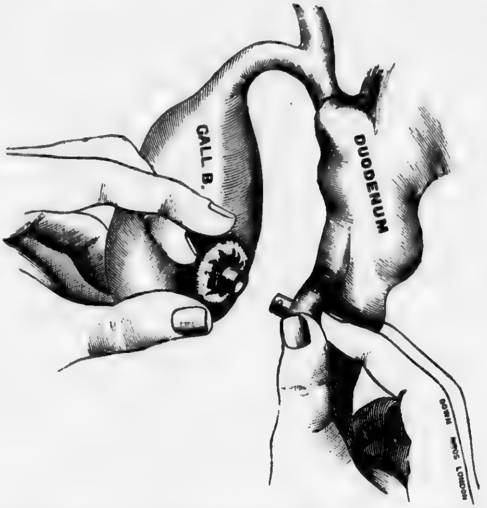


FIG. 309.—METHOD OF UNITING MURPHY'S BUTTON FOR LATERAL ANASTOMOSIS BETWEEN GALL-BLADDER AND DUODENUM. (DOWN BROTHERS.)

(*c*) *Murphy's Button* is probably the quickest, and certainly the most satisfactory, of all the plans that have yet been suggested. The details of its insertion differ slightly from those employed in effecting an end-to-end anastomosis. Incisions are made in the two sections of bowel to be united, each incision being two-thirds of the diameter of the button to be used. The wounds at first only involve the serous and muscular coats. A purse-string suture is now inserted round the incision traversing the whole thickness of the intestinal walls; the mucosa is then incised, and the half-button introduced. By drawing the stitch tight and tying it around the stem of the button, the wall of the gut is gathered into the hollow of the cup. This is accomplished on each side, and then the halves of the button are pressed together in the way shown in Fig. 309. Murphy recommends that after the operation the bowels should not be confined, but should be kept loose, so as to prevent any solid mass of fæces blocking the channel through the button.

6. The establishment of an **Artificial Anus** has frequently to be undertaken in cases of intestinal obstruction, where the onward passage of fæces is prevented by some irremovable barrier. It is sometimes required in the treatment of intussusception, and for rupture or penetrating wounds of the gut. When the small intestine is involved, enterostomy may be undertaken as described above (p. 866); but it must be noted that life is impossible for any length of time with an artificial anus situated more than a foot above the ileo-cæcal valve, on account of the interference with nutrition owing to cutting off such a large extent of absorbent mucous membrane. Some form of short-circuiting operation, or some means whereby the continuity of the bowel is restored, must therefore be subsequently undertaken. Things are, however, different in the large intestine; colotomy is frequently employed in dealing with diseases of the lower bowel, and is an extremely successful proceeding.

The character of the artificial anus varies considerably according to whether or not it is intended to be a permanent condition. If merely a temporary opening is required, the smaller the portion of bowel secured to the parietes the better, since the subsequent operation for its closure is so much simpler. But where a permanent aperture has to be established, the surgeon's aim should be to totally deflect the course of the fæces; and hence it is desirable to entirely withdraw a portion of the gut from the abdominal cavity, and to cut away a complete segment, including also, if possible, a portion of the mesentery. By this means the upper and lower openings are brought to the surface of the skin, and separated from one another by an area of cicatricial tissue representing the section of the mesentery.

Colotomy, or, as it should be correctly termed, 'colostomy,' is an operation for the establishment of an artificial anus in some portion of the large intestine. Any part of the colon may be thus dealt with through a median laparotomy; but one usually prefers to open the termination of the descending colon through the peritoneum in the left iliac region. Formerly the favourite method was to open the descending colon in the left loin behind the peritoneum (left lumbar colotomy or Amussat's operation). Callisen's name has also been associated with this proceeding, but he merely proposed to do it through a vertical incision; Amussat was the first to perform the operation, utilizing a transverse incision, and extending its applicability to both sides of the body.

Uses of Colotomy.—The operation is required under the following conditions: (1) For congenital absence of the rectum, when a perineal incision has failed to discover it: (2) for chronic obstruction of the large intestine, which cannot be relieved by enemata or medical means, such as that arising from simple or malignant stricture, or the pressure of pelvic tumours: (3) for carcinoma of the rectum or sigmoid flexure, whether obstruction is present or not, if a radical operation is impracticable, or as a preliminary to excision: (4) for some cases of syphilitic and other forms of ulceration of the large bowel, which cannot heal as long as they are irritated by the passage of fæces: (5) for irremediable cases of recto-vesical and recto-vaginal fistulæ, whatever their origin: (6) for volvulus of the sigmoid flexure, the inguinal operation being needed, not only to relieve the obstruction, but also to prevent recurrence.

Lumbar Colotomy.—We shall here merely describe the operation as performed on the left side of the body. The patient lies on the right side, with a sandbag beneath the loin, so as to increase the space between the last rib and the crest of the ilium.

The position of the colon is indicated by a vertical line drawn upwards from a point half an inch behind the centre of another line, passing from the anterior to the posterior superior iliac spine.

The centre of the incision should correspond to this line midway between the last rib and the crest of the ilium. It should be made parallel to the last rib, and for practical purposes may commence at the outer border of the erector spinæ, and pass outwards for about 4 or 5 inches (Fig. 336, A; p. 999). This incision is carried through the layers of the abdominal muscles, dividing the latissimus dorsi and a small portion of the external oblique, and beneath this the posterior attachments of the internal oblique and transversalis muscles, constituting the fascia lumborum. This should be cleanly divided along the whole length of the incision, the last dorsal nerve and artery being usually included. The sheath of the quadratus lumborum is opened, and the outer fibres of the muscle notched if necessary. The edges of the wound are now held aside by deep spatulæ, and the loose fatty subperitoneal tissue gently torn through with the fingers and forceps; it varies considerably in amount and consistency. The gut must then be looked for, and may be readily recognised if distended; but if collapsed, a good deal of difficulty is often experienced, though the hand of an assistant pressing back the anterior abdominal wall may bring it into view. It is well to define the lower edge of the kidney by the fore-finger, and the portion of gut lying immediately in front of it is usually the colon. In other cases it may be made evident by injecting air into the rectum.

In about 20 to 30 per cent. of individuals a true peritoneal ascending or descending meso-colon exists, and under such circumstances it is necessary to open the general peritoneal cavity in order to bring the required portion of gut into view; the operation is then completed in the same way as for iliac colotomy, the bowel not being opened for some days if possible.

When, however, the gut has only a partial serous investment, the peritoneal reflections are carefully defined, and the uncovered portion drawn upwards between the fingers into the wound. The highest attainable segment of gut should be selected, so that no loose or slack part may remain above the wound, to give rise later on to prolapse. If possible, the bowel should be left for a day or two before opening it, being secured to the skin by sutures which merely pass through the muscular coat. The horns of the incision are then closed, and the gut incised at a later date.

If, however, the patient is suffering from obstruction, and an immediate opening of the bowel is desirable, the best plan to adopt is to pull the gut well out of the wound, which is then carefully guarded by an antiseptic compress, and to make a small incision into it, in which a Paul's tube is at once tied, so as to allow the intestinal contents to escape without soiling the wound. A few fixation stitches are then applied to the walls of the bowel, so as to prevent it from retracting. The tube will probably separate by about the fourth day, but by this time the wound will be in such a state that no great harm will come from the escape of fæces in the neighbourhood. If a Paul's tube is not to hand, the patient is rolled over on to his back, and a large trocar and cannula inserted, so that the first gush of flatus and fluid fæces may be clear of the wound. On removing the cannula the mucous membrane of the gut is stitched to the margin of the skin, whilst the anterior portion of the incision is sutured, and the small cavity behind the gut packed with gauze. By fixing the bowel as far back as possible, this cavity will be diminished in size. An antiseptic dressing is then applied over a piece of protective to the anterior portion of the incision, and a pad of tenax is placed behind to receive the fæcal discharge. The old plan of fixing the bowel by transfixing it back and front with silk stitches, which are withdrawn after opening the bowel and tied at the four corners, has little to recommend it.

Lumbar colotomy is not much in favour at the present day. It is always a difficult operation if the bowel is not distended; and if an immediate opening is necessary, there is a considerable risk of suppuration of the wound and cellulitis. It has been almost entirely replaced by the iliac operation.

Iliac Colotomy, or Littré's Operation, consists in opening the lower portion of the colon or sigmoid flexure through the anterior abdominal wall. An incision 2 to 3 inches in length is made at right angles to a line extending from the anterior superior spine to the umbilicus, the centre of the incision corresponding to the junction of the outer and middle thirds (Fig. 286, C). The abdominal parietes are divided, and the peritoneum opened. Two fingers are then inserted, and the sigmoid flexure sought for; it is readily recognised by the presence of the appendices epiploicæ, and the longitudinal bands of muscle fibres. It is carefully examined, and the upper part of it selected for fixation in the wound, so as to diminish the risk of subsequent prolapse. It is desirable to withdraw a coil about 4 or 6 inches in length, together with its mesentery. Many different plans of fixing it are in vogue, but the method we prefer is to pass a strong silk thread through the parietes and parietal peritoneum on either side of the wound, the stitch traversing the mesentery *en route*. It is then made to traverse the same structures once more in exactly the same way, but at a distance of about half an inch from the former (see Fig. 310). The loose ends are then tied together, so as to bring the parietal peritoneum and sigmoid meso-colon into close apposition. A few additional stitches may be sometimes inserted with advantage, uniting the skin to the longitudinal muscular bands. Some surgeons simply secure the parietal peritoneum to the gut by a row of carefully inserted sutures; others pass a glass rod through the mesentery and stitch the peritoneum to the skin, whilst it has also been suggested to make a hole through the mesentery and suture the two edges of the incision through it, *i.e.*, beneath the bowel. The projecting portion of gut is then covered with purified protective, and an antiseptic dressing applied. At the end of four or five days the bowel is opened, no anæsthetic being generally necessary for this proceeding. A portion of the whole lumen of the gut should be removed, down to and even including the mesentery, so as to completely separate the upper from the lower end of the gut, and thus establish an efficient spur. Should an immediate opening be necessary, the bowel should

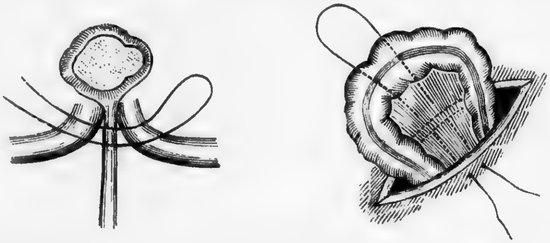


FIG. 310.—ILIAC COLOTOMY TO SHOW FIXATION STITCH PASSING THROUGH MESENTERY AND ABDOMINAL PARIETES.

firstly be very accurately sutured to the skin all round, and then an opening made, and a Paul's tube tied on.

Comparison of the Two Operations.—As we have already stated, the iliac operation has almost entirely superseded the lumbar proceeding, and the reasons for this change of attitude are as follows: (1) The operator is not hampered by lack of space, as so frequently happens in opening the loin. (2) A clean incision can be made without tearing or bruising the subperitoneal fat. (3) The sigmoid flexure is readily identified, and no other viscus is likely to be opened for it by mistake; if the colon takes an abnormal course in the loin, or is provided with a complete meso-colon, the peritoneum has usually, if not always, to be opened, and thus the one advantage which can be claimed for the lumbar proceeding is lost. (4) An artificial anus situated in the iliac region can be attended to by the patient himself without assistance, and is more easily cleansed and protected. (5) It is occasionally possible for a certain amount of sphincteric control to be developed after the abdominal operation, owing to the muscles of the abdominal parietes becoming adherent to the coats of the gut. Of course, this can only be attained when these structures are brought into accurate apposition, as by the fixation stitch described above. (6) A more complete diversion of the fæces can be effected by the iliac operation than by the lumbar. In the latter it is impracticable to withdraw the whole lumen of the gut; an opening is merely made on one side, and one has to trust to the formation of a valve of mucous membrane for the blocking of the lower aperture; in the former the two segments of the bowel can be entirely separated.

The objections urged against the iliac operation consist in the following facts: (1) That it involves the opening of the peritoneum; (2) that immediate relief to obstruction is more risky than in the lumbar method; and (3) that there is a somewhat greater tendency to prolapse. The first of these objections must now be entirely waived. The second is certainly valid, but by a careful use of Paul's tube and by fixing the gut firmly to the skin by additional sutures the danger is minimized. Certainly the lumbar operation is not devoid of risk when an immediate opening of the gut is required. Lastly, if the surgeon is careful to see that no slack portion of gut exists above that which he fixes in the wound, *i.e.*, if he opens the lower end of the descending colon, there will be but little likelihood of any subsequent protrusion.

Appendicitis.

Considerable discussion has arisen of late years as to the best title to apply to the condition which is now to be described. Formerly the terms typhlitis, perityphlitis, and paratyphlitis were utilized, indicating respectively an inflammation of the cæcum, of its peritoneal coat, or of its retroperitoneal connections. It has now been conclusively proved that although true typhlitis does occur, yet in the vast proportion of cases the cæcum plays no part in the trouble, and that the appendix is the all-important element, and therefore the title 'appendicitis' has almost completely supplanted the former. Again, it has been shown that the cæcum and its appendix are almost always completely surrounded with peritoneum, and hence the distinction into peri- and para-typhlitis is quite uncalled for; the inflammation starts in the appendix, then involves its peritoneal lining, and only occasionally spreads into the retroperitoneal tissues by burrowing through the posterior layer of the serous membrane. The importance of appendicitis lies in the fact that the peritoneal envelope is invariably involved in the inflammation, and according to the character and extent of this complication the symptoms and prognosis must necessarily be largely influenced.

Ætiology.—Many different conditions contribute either directly or indirectly in determining an attack of appendicitis. (1) The organ is to be looked on, not as an actively functional structure, but as a degenerated relic or remnant, which is apparently of little value or importance. Hence, as in other similar structures, it has but a poor blood-supply, derived in the male from the ileocolic artery alone, although in the female it has an additional twig from the right ovarian trunk. The latter fact may explain why the disease is less common in females than in males. (2) A large amount of lymphoid tissue is present in its walls, so much, in fact, that the title of 'abdominal tonsil' has been applied to it. Inflammatory processes are thus readily set up within its walls as a result of the absorption of toxines or organisms from the bowel, which are almost constantly present within it. (3) Its length and direction vary considerably in different individuals. In length it may measure anything between 1½ and 6, or even 8, inches, whilst, as to direction, it may lie in any axis; perhaps most frequently it is to be found behind the cæcum, and pointing down towards the pelvis. The facility with which the intestinal contents find their way into its lumen thus varies in different individuals, and it seems probable that appendicitis is more commonly met with where it is so placed as to readily admit material which is with difficulty expelled, *i.e.*, when it is transverse or directed downwards. A long appendix is also more liable to become twisted on itself. (4) The communication with the cæcum is usually a small one, and is guarded by a fold of mucous membrane, known as the valve of Gerlach. Sometimes this aperture becomes blocked, or the orifice stenosed, so that an accumulation of mucus occurs within the appendix. (5) Fæcal concretions or foreign bodies, such as fruit-stones, pips, pins, etc., are also met with within it, and by their presence and irritation may determine an attack of inflammation. Foreign bodies are much less common than was formerly imagined, occurring most frequently in children and young people. The fæcal concretions are usually the result of chronic constipation, which is to be looked on as an exciting cause.

Apart from these, other causes of appendicitis are occasionally described, such as rheumatism, and in chronic cases tubercle or actinomycosis. Typhoid ulceration may occasionally be met with in the appendix, as well as in the neighbouring intestine. Dysentery is sometimes associated with appendicitis, though perhaps more commonly it leads to a true ulcerative typhlitis, involving the cæcum.

Finally, injury in the shape of a strain or sudden twist is not unfrequently mentioned as the cause of an outbreak, and probably acts by displacing a long appendix in such a way as to lead to its kinking and possibly to obstruction of the nutrient artery.

When once an attack has occurred, some stenosis of the lumen of the tube is frequently left behind, causing retention of mucus, in which organisms are sure to be present, thus predisposing to a recurrence.

Pathological Anatomy.—Bacteria find an entrance into the wall of the appendix either through an eroded area of the mucous membrane due to the impaction of a foreign body or of a fæcal concretion, or else they are absorbed into the lymphoid tissue so abundantly present, and at once commence to develop and multiply. As a result of this the mucosa becomes greatly swollen and thickened, and as it is surrounded by fairly strong muscular walls, constriction of the vessels follows, preventing recuperative processes from being undertaken, and hence the bacteria are enabled to continue their destructive work. In consequence, ulceration of the mucous lining supervenes, or interstitial suppuration in the wall. Sometimes the small terminal artery of the appendix becomes thrombosed, or undergoes an obliterative endarteritis, leading to sloughing of one or more portions of the walls, generally at the apex. The veins also are liable to become thrombosed, and bacteria may find their way into the thrombus, causing its disintegration, and if emboli are detached, pylephlebitis or portal-vein-pyæmia, with possibly hepatic abscess, may result. The most important changes, however, are those occurring in the peritoneum, which is always inflamed, and, indeed, upon the condition of this structure depends to a large extent the prognosis of the case. It may merely be thickened by a deposit of lymph, giving rise to adhesions which bind it down to neighbouring parts, or a localized suppurative affection may follow; or, again, an acute diffuse and usually fatal peritonitis follows, either as a result of rupture of the appendix, or as an outcome of sloughing or perforation of its walls. The localized abscess is in reality intraperitoneal, but its extension is limited by the formation of adhesions between neighbouring coils of gut. When an attack of appendicitis has passed off, some stenosis of the lumen of the tube is a common sequence, and as a result of this the terminal portion may become distended with retained secretion, and the patient may suffer from intermittent attacks of colicky pain due to the efforts of the appendix to relieve itself; it will also predispose the individual to recurrent inflammation.

Hence, from a clinical standpoint, the following *varieties* of appendicitis may be recognised:

1. Simple or catarrhal appendicitis, associated with a plastic peritonitis.
2. Ulcerative or gangrenous appendicitis, accompanied by a localized intraperitoneal abscess.
3. Gangrenous or perforative appendicitis, resulting in an acute diffuse sero-purulent peritonitis. Such a condition is frequently fatal, and constituted one of the commonest causes of the so-called 'idiopathic peritonitis' of the old days.
4. Relapsing appendicitis, in which attack follows attack, sometimes with very little interval between.

Clinical History.—(i.) The mild variety of the disease, known as a simple *catarrhal appendicitis*, to which is added merely a localized plastic peritonitis, usually commences somewhat suddenly, the patient being seized with pain in the right iliac fossa, and accompanied by nausea, vomiting, more or less complete constipation, and slight fever (101° or 102° F.). An examination of the abdomen reveals definite tenderness in the right iliac region, most marked at a spot corresponding to the base of the appendix, *i.e.*, 1½ inches inwards from the anterior superior iliac spine, along a line drawn towards the umbilicus (McBurney's spot), whilst the right leg is usually drawn up in order to relax the tension of the abdominal muscles. A swelling, generally dull on percussion, may sometimes be detected by palpation, and consists of coils of intestine matted together over and around the inflamed appendix. Such symptoms usually last three or four days, and then, if properly treated, resolve satisfactorily without any abscess formation.

This simple form of the disease is exceedingly common, and the prognosis is, on the whole, favourable. Tofft, of Copenhagen, found adhesions in the neighbourhood of the appendix in 35 per cent. of all bodies subjected to post-mortem examination.

(ii.) The more serious variety, commonly resulting in a localized abscess, commences in a similar way, but the symptoms are a good deal more acute. There may be an initial rigor, and the temperature soon runs up, even to 104° F. Some general abdominal tenderness and distension follow, and there is no abatement, but rather an increase, in the symptoms at the end of the first three days. Constipation is often absolute, and fæcal vomiting may occur. The muscles on this side of the abdominal wall are held tense and rigid, and a well-marked swelling can usually be detected in the iliac fossa. Under a careful régime this may disappear, and the symptoms gradually abate in their severity, the temperature and the pulse falling concurrently; but it is very common for suppuration to ensue, and such is indicated by the temperature persisting at its original high level, or by the pulse-rate increasing in rapidity, whilst the temperature falls. Fluctuation is rarely to be detected in the early stages, and, indeed, it is bad practice to wait for it before interfering, since there is a considerable probability that the tension within the abscess may be sufficient to break down the wall of newly formed and not too strong adhesions, and the general peritoneal cavity may be thus infected. The abscess develops at first around the appendix, and is, of course, primarily intraperitoneal. Not unfrequently it bursts into the bowel, and thereby relief is gained without the assistance of surgery; some authorities, indeed, maintain that this occurs in every case of the more severe type which resolves. In other instances it may point externally, either through the anterior abdominal wall, which becomes congested and œdematous as the pus approaches the surface, or through the loin, the pus having invaded the retroperitoneal cellular tissue. In the latter case, it is sometimes found that the abscess burrows widely up and down the back of the abdomen, and may even extend behind and above the liver, constituting a subphrenic abscess. In other patients, and especially when the tip of the appendix lies over the brim of the pelvis, the pus travels downwards and forms a collection behind the rectum; the surgeon must never omit a rectal examination in appendicitis, where the temperature is of such a nature as to suggest the existence of an abscess, and yet no evidence of one can be found. Should it burst into the peritoneal cavity, all the phenomena of perforative peritonitis supervene, probably indicated by a sudden fall of temperature, and followed by increased abdominal pain and distension. In other cases the patient's general symptoms improve after the first outbreak; but the focal trouble persists, and gradually a fluctuating swelling forms, which, on being opened, proves to be a chronic abscess; some peculiarity in the type of organism present is the probable cause of this occurrence. A fæcal fistula may result from the bursting or opening of any of these abscesses.

A complication which must always be looked out for in these more severe types of the disease is pylephlebitis, or infective thrombosis of the branches of the portal vein in the liver. Such would be indicated by recurrent rigors, and possibly by pain and tenderness in the hepatic area. Necessarily it is almost invariably fatal.

(iii.) *Diffuse septic peritonitis* results either from the rupture of a localized intraperitoneal abscess, and will then be preceded by the symptoms outlined above, or is present from the outset, being then due to primary perforation or rupture of the appendix itself. The ordinary signs of acute peritonitis are developed (see p. 837), but possibly there may be obtainable some history of pain starting in the right iliac fossa, which will give a clue to the diagnosis.

(iv.) *Relapsing appendicitis* is characterized by recurrent attacks of varying gravity in an individual who has been once the subject of the disease. They may occur only at prolonged intervals, or be so frequent as to entirely incapacitate the patient, and are mainly due to the presence of some abnormal adhesion or constriction of the appendix. It is not uncommon for the appendix to become fixed to the sheath of the psoas muscle, and then any excessive movements of the limb may light up an attack. Where stenosis exists, secretions containing bacteria may be pent up behind the constriction, and from time to time the patient suffers from severe pain of a colicky nature without fever, supposed to be due to an attempt to get rid of the excess of mucus. Such attacks have been named 'appendicular colic.' In a few cases the appendix becomes totally obliterated after a time and incorporated in a mass of adhesions, a natural cure being thus established; but more frequently, if these recurrences are allowed to continue, the patient finally succumbs from diffuse peritonitis or possibly pyæmia.

The **Diagnosis** of appendicitis ought not to be a matter of great difficulty if the practitioner bears in mind the cardinal symptoms, viz., pain and tenderness in the right iliac fossa, especially referred to McBurney's spot, together with fever, vomiting, and constipation. If to these are superadded the existence of a localized swelling beneath the tense and rigid abdominal muscles, but little doubt can remain as to the nature of the case.

The **Prognosis**, on the other hand, is never absolutely certain, for, as has been well pointed out by many acute observers, the initial symptoms are frequently alike in all the varieties, and hence one can never know what course the case is going to take; as R. Morris of New York says, 'The infected appendix is a cap which sometimes snaps, sometimes flashes, and sometimes causes an explosion, and none of us can tell in advance just what is going to happen.' As particularly bad signs may be mentioned a continued high temperature, in spite of rest and careful dietetic measures, or a fall of temperature with increased rate of the pulse.

Treatment.—So much has been written on this subject during the last ten years, that it is extremely difficult to compress even a brief summary of the many facts observed into a necessarily limited space. Formerly typhlitis was the exclusive property of the physician; but the last decade has brought about a great change, and many authorities consider that appendicitis is more justly within the realm of the surgeon, or, at any rate, that a surgeon should always share the responsibility of treatment with the physician. At any moment complications may develop even in what appear to be simple cases, in which surgical assistance will alone hold out any hopes of saving the patient. In America surgery is the recognised treatment for almost every case of the disease; in this country more conservative ideas still persist, but we are glad to note that a more healthy opinion is gradually gaining ground, and that surgical interference is becoming recognised as the most appropriate means of treatment in many cases.

In the milder form of appendicitis, where the temperature does not run above 101° and the symptoms are not severe, all that is required in the majority of instances is to put the patient to bed, and apply hot fomentations locally; the lower bowel should be emptied by an enema, and if it seems likely that there is an accumulation of irritating fæces within the intestine, a dose of castor-oil or of calomel may be administered. A fluid, unstimulating diet is all that is permitted, and should there be much vomiting, rectal alimentation may be resorted to. Possibly a little morphia may be given with advantage to quiet the patient and check peristalsis; but the less the better, since it tends to mask symptoms.

In the graver cases the same general treatment may be instituted to start with, but the question as to the advisability of operation will soon have to be faced. There are certain conditions in which all surgeons are agreed as to *operation* being *essential*, viz., where general peritonitis is present, or when an abscess is pointing. In the former case the only hope that exists, and even that is of the slenderest description, lies in opening the abdomen (usually in the middle line), flushing it out with some weak antiseptic lotion, or perhaps better with sterilized salt solution at a temperature of about 108° F., and then searching for the appendix. If found, it should be removed, and then drainage, either by Keith's tubes or by gauze wicks, must be arranged for. In the great majority of cases death will ensue in spite of all our precautions, but the more recent reports certainly hold out a better prospect of success.

When an abscess is evidently present or indicated either by fluctuation or by a commencing œdema of the abdominal wall, there should be no hesitation in cutting down. An incision is made over the œdematous spot, and deepened carefully, since the tissues are probably matted together, and cut like bacon or brawn. The knife or index-finger will suddenly sink into the abscess cavity, and a gush of fœtid pus follows. The cavity is gently explored, so as to ascertain whether or not the appendix can be felt; no undue violence should be used, for fear of breaking down adhesions and thus opening the peritoneal cavity. If the appendix cannot be readily found, it is best left alone; the abscess sac is merely washed thoroughly out, drainage is provided for, and the incision partly closed. Probably the case will go on well, the discharge losing its smell about the third day, and the remaining sinus will gradually heal by granulation. Should the appendix, however, present itself, it should be removed according to the directions given below.

It is, however, in those cases where neither of the above conditions are manifest, and yet the symptoms, both local and general, point to the fact that a lesion of considerable gravity is present, that the greatest difference of opinion exists. We are forced to admit that in many instances conservative or medical treatment will suffice to bring about a satisfactory result; but this can never be depended on, and, unfortunately, only too many patients' lives have been sacrificed through an unwillingness to call in the surgeon, except at the last moment. Under these circumstances, even if acute peritonitis has not occurred, the patient is profoundly toxæmic or exhausted by preceding suffering; hence any operative measures are likely to fail through the asthenic condition of the individual, even if the local phenomena are such as can be efficiently dealt with. Personally, we are distinctly in favour of early operation, and the general rule (to which, of course, there are exceptions) which we would suggest as justifiable is that, *if in spite of suitable rest and medical treatment the symptoms, both general and local, are not commencing to abate at the end of forty-eight hours, operation should be undertaken.* The great advantages we would claim for this procedure are: 1. That the patient is not profoundly toxæmic, or in a state of collapse, and hence can stand the shock of an intraperitoneal exploration without much risk; 2. that the appendix itself is not so likely to be tied down by a mass of firm adhesions, and can thus be found, isolated, and removed; 3. that such removal is most desirable in order to secure the patient against the danger of recurrence; and, 4. that a much smaller incision will be needed under these circumstances, and therefore there is less chance of a ventral hernia subsequently forming. It is only necessary to mention the fact that several American surgeons have been able to report hundreds of cases dealt with in this way with a mortality well under 5 per cent. to prove that there is much to be said in its favour.

Operation.—Probably the best incision is an oblique one, crossing McBurney's spot, and parallel with Poupart's ligament, somewhat similar to that for ligaturing the external iliac artery (Fig. 286, D). The whole thickness of the abdominal wall is freely divided, and the peritoneum, if need be, opened, so as to expose the cæcum. The appendix is then carefully sought for, after protecting the general cavity by sponges; it may be necessary to lift the cæcum from its bed in order to find it, or to separate agglutinated coils of intestine. In cases of difficulty, the longitudinal bands of muscle on the ascending colon should be traced downwards to the appendix, where the three sets of fibres converge. An abscess usually containing extremely offensive pus may be opened in this way; but if the operation is an early one, there is often no pus around the appendix, although its walls may be yellow from purulent infiltration. Whenever possible, the appendix should be removed; it is first freed from adhesions, and the meso-appendix ligatured; a silk thread is then tied around the base about half an inch from the cæcum, and the appendix cut off; the stump should be touched with pure carbolic acid, and, if practicable, buried by the insertion of two or three sutures into the serous membrane covering the cæcum. Not unfrequently, however, the tissues are too much infiltrated and matted together to admit of such proceedings; all that can then be done is to plug the wound with gauze, and allow it to heal by granulation. In the earlier more favourable cases, where actual suppuration has not occurred, the cavity is washed out after removal of the appendix, a drainage-tube inserted, and the abdominal wall closed as far as possible. After the operation, the patient should be fed mainly per rectum for a few days, stomach-feeding being gradually commenced about the third day. A small amount of opium may be needed, and, if all is going well, the bowels may be opened by the use of enemata in about five days if they have not already acted.

For *relapsing appendicitis*, radical treatment must be instituted if the attacks are at all frequent. Such consists in cutting down on the part during a quiescent interval, and removing the appendix, a task by no means always easy, owing to the number and density of the adhesions which may be present. They are dealt with in the best way practicable, and the appendix thus freed is amputated. This is accomplished by dividing the serous coat by a circular incision, and retracting a cuff of serous and muscular tissues sufficiently to enable the mucous membrane to be ligatured, touched with pure carbolic acid, and then covered over and buried, stitching the serous membrane over the end.

Sequelæ.—A *Fæcal Fistula* may result from a perforative appendicitis when the abscess has been merely opened, and no radical treatment undertaken at the same time. It is usually small in size, and sinuous in its course, and may in many cases close of itself. Occasionally it is necessary to deal with it by laying bare the cæcum in the iliac fossa, and removing the appendix.

A *Ventral Hernia* sometimes follows from the yielding of the cicatrix in the abdominal wall after an abscess has been opened and drained. Both omentum and bowel, perhaps matted together and adherent to the cicatrix, are found in the protrusion. In some cases it may suffice to cover it with the concave pad of a truss, but in others operation is required; adhesions must be divided or broken down, and often the opportunity can be taken of removing the appendix, if this has not already been accomplished. The margins of the divided muscles are then sought for, and united by a row of buried sutures in the ordinary way.

Affections of the Liver.

Rupture of the Liver is produced by injuries to the abdominal wall, such as blows, kicks, or crushes, or it may be torn by the broken end of a rib. Penetrating injuries also occur, as from sword or dagger thrusts, and the organ may be involved in a gunshot wound. The resulting lesion varies considerably; the gland may be merely torn or contused from a non-penetrating blow, or freely incised by a sharp cutting implement, in which case some of the larger venous trunks may be divided; a bullet may sometimes produce almost total disorganization. The amount of injury depends, to some extent, on the condition of the organ; if it is firm and sclerosed, it may receive little damage from a blow which would otherwise do it considerable harm, whilst if it is enlarged and fatty it is readily torn.

The chief **Symptoms** are shock, which is often not very excessive, pain and tenderness in the right hypochondrium, and the evidences of loss of blood. The last is, perhaps, the most important, as upon its severity depends to a large extent the result. Sometimes the capsule remains intact, although the glandular tissue is injured, and then, although there is considerable intraglandular ecchymosis, no free blood escapes into the peritoneal cavity. Such a lesion is not unlikely to lead later on to an abscess of the liver. If the capsule is torn, intraperitoneal hæmorrhage is sure to ensue; if slight, the patient, though suffering from all the phenomena characteristic of loss of blood, may recover, the blood being absorbed, and the wound in the liver cicatrizing. This process is usually attended by a certain amount of jaundice, and some vomiting, which may be bile-stained, whilst the urine is also tinged with bile pigments. In other cases, the blood collects at first in the upper part of the abdomen, but gradually extends downwards; if the bowel is uninjured, recovery may ensue, but not uncommonly there is some associated contusion of the gut wall, through which intestinal bacteria find their way, giving rise to a localized or general peritonitis. Of course, in the more severe lesions of the liver, where perhaps the left lobe is entirely torn off or a portion hopelessly contused, death from hæmorrhage is almost certain to ensue in a very short time.

The **Diagnosis** of hepatic rupture turns mainly on the history of the accident, the situation of the blow, and the resulting symptoms. Evidences of intraperitoneal bleeding, associated with pain in the right side, are extremely suggestive. It must not, however, be forgotten that the passage of a hansom cab or other vehicle over the body may give rise to much shock, and to considerable local pain and tenderness, and yet no serious mischief need have happened to the liver.

The **Treatment** in the more simple cases consists merely in careful expectancy, the surgeon holding himself in readiness to interfere should any untoward symptoms supervene. The patient is kept quietly in bed; ice may, if necessary, be applied to the side, the diet is limited to fluids, and the bowels emptied by enemata. In the more serious cases, where the diagnosis of ruptured liver is tolerably certain, an exploratory laparotomy should be undertaken, and an attempt made to deal with the wound. Possibly a median incision is as good as any, since the left half of the liver often bears the brunt of the injury. Outlying ragged portions of the gland may be totally removed, preferably by the cautery, though one usually has to depend upon plugging the wound with gauze in order to effect hæmostasis. Clean linear cuts may be sutured with silk, but there is considerable difficulty in preventing the stitches from tearing out of the friable hepatic tissue; it is wise to insert all the stitches first, taking up a good margin of the gland substance before attempting to tie them. Very shallow wounds which it is impossible to stitch or plug satisfactorily may be seared with the cautery so as to stop bleeding, and then a gauze-wick drain is placed over them, and brought out of the external wound.

Abscess of the Liver may occur in several forms, and be due to a variety of causes. 1. *Multiple abscesses* develop in cases of pyæmia, whether the emboli are carried by the hepatic artery or by the portal vein. In the former case, the condition arises as a complication of general pyæmia of systemic origin; in the latter, the originating focus of mischief is located in the area of distribution of the portal vein—*i.e.*, in the intestinal canal. Thus, pylephlebitis, as it is termed, is not uncommonly met with in appendicitis, and sometimes in typhoid fever, whilst suppurating piles may also lead to it. 2. The more important abscesses, from a surgical standpoint, are those which are *single*, and these, from their size, demand surgical treatment. They may result from traumatism in the way stated above, or may arise in connection with hydatid cysts, but more commonly are of the type known as *tropical abscess*. The latter usually occurs in individuals who have travelled in the tropics, and 75 per cent. of the cases are attributed to dysentery. The exact mode of causation has not yet been fully worked out, but it seems probable that they are primarily of embolic origin. Any of the ordinary pyogenic organisms may be found within them, and not unfrequently the *Bac. coli* is present. In a few cases the *Amœba coli*, an organism which is often found in the bowel in dysentery, has been discovered. Occasionally the pus is sterile, the causative organisms having probably been disposed of, possibly as a result of the antiseptic properties of the bile. The abscess wall consists of disintegrating hepatic tissue in acute cases, but may have a fibro-cicatricial wall in the more chronic forms, and in an old-standing abscess the limiting membrane may be as tough as leather. The pus is sometimes of the ordinary type, but not uncommonly reddish-brown in colour, somewhat like chocolate, and of a most nauseating odour.

The **Symptoms** are in some instances extremely slight, the patient perhaps dying of peritonitis due to its rupture without its presence having ever been suspected. As a rule, however, the individual complains of a sense of weight and fulness in the right hypochondrium, and in the more acute cases this may be accompanied by severe pain and localized tenderness over the whole hepatic region, the pain being also referred to the right shoulder. A certain amount of febrile disturbance occurs, the degree of which depends on the rapidity of formation of the abscess; in the more acute forms the temperature is high and rigors may be present. The pyrexial phenomena are associated with loss of appetite, rapid and well-marked emaciation, and perhaps a certain amount of icterus, though the latter is not usually a prominent phenomenon. On physical examination a more or less evident enlargement of the liver will be detected, with, perhaps, a feeling of elasticity, or even of fluctuation at some spot. A doubtful diagnosis can sometimes be confirmed by the aspirator or hypodermic needle, but this should not be utilized unless one is fully prepared for immediate operation in the case of pus being found. Left to itself, several distinct courses are open for the abscess to follow: it may become adherent to the anterior abdominal wall and point in the epigastrium, its onward passage being indicated by congestion and œdema of the parietes; it may open into the peritoneal cavity, or into one of the hollow viscera, such as the colon or duodenum; or, again, it may travel upwards, burrowing through the diaphragm, and either bursting into the lung, its contents being expectorated, or into the pleural cavity, leading to an empyema.

Treatment.—*Aspiration*, repeated once or twice, has been frequently employed, but it is of little value, and not a few cases are on record in which septic peritonitis or pleurisy has followed the introduction of the needle from the front or side respectively. Experience proves that the usual law of treating suppuration ought to be strictly obeyed, viz., that the abscess should be opened and drained. If pointing in front and adherent to the parietes, there is no difficulty or danger in making an incision over the most prominent spot and laying the cavity open; it is then well flushed out and a drainage-tube inserted. If on dividing the abdominal parietes it is found that the liver is not yet adherent, it is best to plug the wound with sterilized or antiseptic gauze so as to determine the formation of adhesions to such an extent as to cut off the general peritoneal cavity; in a few days the abscess can then be opened with safety. If there is no great thickness of hepatic tissue between the surface and the pus, a knife may be employed for this purpose; but if the abscess lies deeply, it has been suggested that the thermo-cautery should be employed so as to prevent bleeding, and also to seal the mouths of the hepatic veins, and thus prevent their infection with the pus. When it is urgently necessary to open the abscess at once, even though no adhesions are present, the general serous cavity must be carefully protected by sponges or pledgets of gauze before evacuating the pus, and the assistant must keep the parietes in close contact with the hepatic tissue. It may be possible to insert a few stitches through the liver substance, securing it thus to the parietal peritoneum; otherwise one must trust to a careful packing of the wound. After opening the abscess, it is usually advisable to wash it out, and this may with advantage be repeated subsequently. Sometimes the pus tends to point laterally, and then it must be dealt with from the side. A similar proceeding is sometimes needed when an abscess has been opened from the front, and does not drain properly. An incision is made a little behind the mid-axillary line through the ninth or tenth intercostal space, and a portion of one of the adjacent ribs removed. The pleural cavity is opened, and the costal pleura stitched carefully to that portion which covers the diaphragm; it will be found that this structure lies nearly vertically in this position, and but little difficulty will be experienced in shutting off the general pleural cavity. The diaphragm is then incised, and not unfrequently the peritoneal cavity is opened; if so, it may be stuffed temporarily, so as to determine adhesions, and then the liver incised; less commonly, adhesions may have already formed, or a bare area of the liver may be found, through which the pus can be withdrawn.

Hydatid Cysts occur in the liver more frequently than in any other part of the body. For general details as to the life-history of the *Tænia echinococcus* and the structure of hydatid cysts, see p. 170. They produce a localized painless enlargement of the liver, the cysts varying in size from a small marble to a child's head; the outline is well defined if superficial, but not so if placed deeply; the cavity is usually filled with fluid and daughter-cells. Fluctuation may be distinguished, and a hydatid fremitus or thrill (arising from the concussion of the contained daughter-cysts) may, it is said, be elicited on palpation. The diagnosis is easily made if the cyst projects from the lower border, but when deeply embedded in the organ it may be exceedingly difficult, and the tumour can only be distinguished with certainty from carcinoma or syphilis by the use of the aspirator, or preferably by an open exploration. The character of the fluid withdrawn from a hydatid cyst is at once conclusive, as it is of low specific gravity, viz., 1007 to 1009, slightly opalescent, with no albumin, and a trace of salt; the presence of scolices or hooklets is the pathognomonic feature.

Terminations.—The cyst may remain latent and innocuous, or may actually dry up and form a mass somewhat like wet mortar, owing to the death of the organism; or it may burst and be evacuated in different directions, with or without suppuration. Thus, it may open externally through the abdominal parietes, or into the peritoneal cavity, causing fatal shock and in many cases peritonitis; or into the stomach or intestines, spontaneous cure usually resulting; or it may penetrate the diaphragm, and the contents be expectorated, or set free in the pleural cavity, causing a rapidly fatal pleurisy. It has been known to open into the pericardium, or even into the hepatic veins, the contents then being impacted in the right auricle; in both cases immediate death resulted.

Treatment.—The ideal plan of dealing with a hydatid cyst would be to *dissect it entirely away*, and such is not altogether impracticable in cases where the growth is superficial, since its connections with surrounding parts are not very intimate. The great danger to be dreaded is hæmorrhage, and owing to the vascularity of the liver and the difficulty of controlling bleeding from it, this is an objection of the gravest importance. However, if the tumour is small and superficial, there need be no fear in attempting it, the cavity being firmly plugged with gauze for a few days.

The surgeon, however, usually has to content himself with *incision* of the cyst, turning out the scolices or daughter-cysts, and inserting a large drainage-tube. If adhesions to the anterior abdominal wall are present, this can be accomplished at one sitting; but if, as more commonly happens, none have been developed, it is wiser to undertake the operation in two stages, as for hepatic abscess, so as to make certain that the general peritoneal cavity is firmly shut off. Another advantage which follows the division of the operation into two parts is that the latter proceeding, viz., the incision of the liver and cyst, can be undertaken without an anæsthetic, and the patient is enabled to help in the removal of the cysts by coughing when required.

Formerly *aspiration* and *electrolysis* were largely employed in the treatment of this affection. It has been found, however, that although a very considerable percentage of cases could be cured in this way (more than a half), yet that it was not unaccompanied by risk of peritonitis, and that recurrence was often observed. Moreover, some of the fluid not unfrequently leaked into the peritoneal cavity, and probably from the absorption of some toxic product present led to urticaria, and sometimes to even graver phenomena of poisoning. Electrolysis merely acts by producing a puncture of the cyst wall and consequent leakage. Both of these methods should be entirely discontinued.

A suppurating hydatid cyst is dealt with according to the same rules of treatment as hold good for abscess of the liver.

Tumours of the Liver are rarely primary. Secondary sarcoma and carcinoma are by no means uncommon, but of course nothing can be done for them. A few cases are on record of removal of a tumour or gumma together with a portion of the tissue of the organ, but such must necessarily be a matter of such rarity that we cannot spare space to discuss it.

Affections of the Gall-Bladder and Biliary Passages.

Rupture of the Gall-Bladder is met with as the result of such injuries as blows, crushes, kicks, etc., whilst it may also be produced by penetrating wounds or bullets; occasionally it may follow ulceration from within, as from a large impacted gall-stone. It must be remembered that in health the gall-bladder is occupied not by bile, but by mucus, and that its function is apparently not to act as a bile reservoir, but as a pressure gauge controlling the escape of bile into the intestine. Whenever the biliary passages are stenosed or blocked, however, bile regurgitates, as also after death, and necessarily if the bladder is ruptured, bile will find it easier to escape in this direction than down the long and sinuous bile-ducts, and therefore extravasation of the secretion into the peritoneal cavity always follows. Bile is usually sterile, but if any inflammation of the biliary passages has been present, organisms are sure to have found their way into the gall-bladder, and thus complications may readily ensue. If a considerable quantity of bile escapes suddenly into the peritoneal sac, acute peritonitis is certain to follow, whether organisms are present or not, owing to the irritating nature of the fluid; jaundice is also soon developed from absorption of bile by the peritoneum, and it may also be found in the urine. A more gradual escape of the secretion will probably lead to the formation of a localized intraperitoneal abscess or collection of fluid, associated with jaundice and probably clay-coloured stools. In a penetrating wound bile and blood will escape on the surface, and septic peritonitis is almost sure to follow.

The immediate **Symptoms** will be those of shock and severe hypochondriac pain, and this will be succeeded by either acute peritonitis or by the formation of a localized intraperitoneal swelling, together with jaundice. When the existence of such a lesion is suspected, **Treatment** always consists in an exploratory laparotomy. The fluid within the abdomen is carefully removed with swabs or washed away, and the gall-bladder carefully examined. Should only a small injury be found, it is perfectly feasible to close it by sutures; a gauze wick should, however, be passed down to the lesion for a few days so as to provide a means of drainage should leakage occur. A more serious rupture will necessitate removal of the gall-bladder, or else the margins of the wound may be stitched to the abdominal parietes, and a biliary fistula thus produced. Should the common bile duct be entirely divided, the ends should be closed by sutures and a cholecystenterostomy undertaken; a small wound in the duct may be sutured.

Cholelithiasis is the term applied to the presence in the gall-bladder of **Gallstones.** These consist mainly of crystals of cholesterine, held together by mucus and coloured by the bile pigment; they are soluble in chloroform. When first passed and moist, their specific gravity is a little higher than that of water, and hence when immersed in it they sink; after drying, however, they are found to float. The number present varies immensely; sometimes a single large one exists, which is more or less barrel-shaped; more frequently they are multiple, and then usually facetted, and with a satin-like yellowish lustre.

The **Origin** of gallstones is not yet fully understood, but there seems no doubt that they are primarily due to an inflammatory condition of the walls of the gall-bladder or biliary passages; they occur most commonly in women who have suffered long from dyspepsia and constipation, and may be associated with cancer. In a case dealt with by one of us, the origin of the trouble seems to have been the swallowing of a pin many years previously, which worked its way into the gall-bladder, set up an inflammation which resulted in the formation of calculi, and only appeared again after a successful operation, when sixty-six stones had been removed.

The **Symptoms** produced are extremely variable. Their occurrence is usually preceded by dyspeptic phenomena, which have perhaps lasted for years, and by constipation. Some pain is complained of in the right hypochondrium, but possibly nothing very serious is noted, until a physical examination reveals the distended gall-bladder, which forms a tumour projecting from under cover of the ribs, usually the 8th or 9th, and tending to enlarge downwards towards the umbilicus; it is usually firm, elastic, and perhaps fluctuating; it moves with the liver during respiration, and there is never intestine in front of it. Such a condition generally yields to medical treatment; the diet has to be carefully regulated, and a sufficient amount of exercise ordered. Alkaline purgative medicines are usually employed, and a well-to-do patient may be sent to Carlsbad to drink the waters. Possibly massage may be employed to assist in the extrusion of the calculi, and drinking considerable quantities of olive-oil is also beneficial in effecting the same object.

There are several complications, however, which may call for surgical treatment.

1. Inflammatory phenomena connected with the gall-bladder (*cholecystitis*) may assume considerable proportions. Acute inflammation is usually due to infection with the *Bac. coli*, which

travels up the biliary passages from the intestine. It is evidenced by acute pain and tenderness in the right hypochondrium, together with vomiting, constipation, and fever. The constipation may be of such a marked character as almost to amount to obstruction, and arises mainly from paralysis of the neighbouring coils of gut, *e.g.*, the duodenum and transverse colon. Suppuration may follow, the abscess either bursting externally or into the peritoneal cavity, or possibly into one of the hollow viscera. In other cases the inflammation subsides after a time, but results in a considerable development of adhesions which interfere with operative proceedings, and may also determine an attack of intestinal obstruction. A similar condition due to chronic peritonitis is likely to follow whenever calculi remain lodged in the gall-bladder for some time.

2. *Biliary colic* is another most distressing complication, due to the onward passage of gallstones along the ducts. The pain is of a most acute character, doubling the patient up, and causing considerable shock; it radiates from the right side, shooting over the scapular region and into the back; it commences abruptly, and continues in paroxysms until the stone is either discharged into the intestine or slips back into the gall-bladder, leading to a sudden cessation of the pain; a sense of tenderness and discomfort may, however, persist for some time, and possibly a little jaundice, owing to the swelling of the mucous membrane obstructing the passage of bile. These attacks sometimes come on at more or less regular intervals, and may be so frequent as to produce great exhaustion. At the time, they should be treated by the application of hot fomentations to the side, and the administration of opium; sometimes a large dose of olive-oil by the mouth may assist in the passage of the stone. If they recur at all frequently, cholecystotomy must be undertaken.

3. A gallstone does not always escape into the bowel; it may become *impacted*, and then gives rise to a train of tolerably characteristic symptoms, which vary somewhat with the site of obstruction. If the cystic duct is blocked, there is severe pain in the side, and perhaps distension of the gall-bladder with mucus, constituting a tumour which can be felt, but there is no jaundice. If the calculus is lodged at the junction of the common and hepatic ducts, there will be intense icterus, but the gall-bladder is not distended; the liver, however, is likely to be enlarged from engorgement with bile. When the stone is impacted in the common bile duct, both jaundice and distension of the gall-bladder will result. Sometimes the stone lodges close to the intestinal end of the duct in what is known as the ampulla of Vater; it may then ulcerate through into the bowel without much difficulty. If impacted higher up, it may also give rise to ulceration, which either extends into the duodenum, thus setting the stone free, or lays open the retroperitoneal cellular tissue, leading to an abscess; or,

again, it may open the peritoneal cavity, and thus cause acute peritonitis. In any case, considerable stenosis of the bile-ducts is likely to follow, giving rise subsequently to permanent icterus.

Operative Treatment of Cholelithiasis.—The conditions which may call for operation in the course of a case of gallstones are as follows: (*a*) For recurrent attacks of biliary colic, which cannot be prevented by medical treatment; (*b*) for persistent jaundice; (*c*) when the gall-bladder can be felt enlarged and tender; and (*d*) for acute cholecystitis.

Cholecystotomy consists in opening the gall-bladder for the removal of calculi, or for purposes of drainage. It is performed by means of an incision which runs parallel to the costal margin on the right side, extending upwards as far as the middle line (Fig. 286, B). The peritoneum is opened, and the gall-bladder sought for, any adhesions present being carefully divided; it will sometimes happen that these are so abundant as to prevent the surgeon from continuing the operation, the risk of opening the bowel by mistake being too great. The liver is drawn up, and the intestines are pressed downwards out of the field of operation by means of sponges or cloths held in position by a broad retractor. The general peritoneal cavity is thus carefully guarded from infection. If the gall-bladder is much distended, it is advisable to tap it with a trocar and cannula, and withdraw the chief portion of its contents; the opening is then enlarged sufficiently to allow of the introduction of a scoop, or even of the finger, and by this means the calculi are evacuated. The bile-ducts are carefully examined both by the finger passed inside as far as possible, and outside along their whole length, and by means of a long probe passed down the duct. If no further stones are found, and the interior seems to be tolerably healthy, it is advisable to suture up the wound in the bladder, the threads not being allowed, however, to encroach on the mucous membrane. A gauze wick should be inserted down to the incision before stitching up the abdominal parietes, so as to provide for drainage should there be any leakage of bile. If it seems undesirable to close the wound in the gall-bladder, a full-sized drainage-tube without any lateral openings is introduced, and stitched to the skin, whilst it is also desirable to secure the margins of the wound in the gall-bladder to the parietal peritoneum. A biliary fistula is thus produced which discharges for a time; but as soon as the obstruction to the onward passage of bile into the gut is overcome, the fistula closes. Occasionally, however, this does not occur, and then the discharge of bile continues, necessitating further treatment. If there is sufficient evidence of the existence of bile in the motions to indicate that the passages are clear, a plastic operation for the closure of the fistula may be undertaken; but if complete and permanent obstruction to the passage of bile is suspected, an artificial communication with the intestine (cholecystenterostomy) should, if possible, be established.

It is often very difficult to remove a stone impacted in the bile duct. Possibly it may be pushed on from within, or squeezed forwards or backwards by the finger and thumb from outside; or, again, it may be broken up from within by means of a needle, or crushed from without by forceps, the blades of which are guarded by indiarubber. The duct has also been incised, and the stone thus set free, the incision being subsequently secured by Lembert's sutures, long-handled palate needles being employed for this purpose. In other cases the stone is left alone, and in the course of a few days it may become dislodged by natural means, as evidenced by the passage of bile into the intestine.

Cholecystenterostomy, or the formation of an artificial communication between the gall-bladder and the bowel, is called for in cases where jaundice persists, owing to absolute stenosis of the common duct. It has also been undertaken for the relief of jaundice due to malignant disease, either of the head of the pancreas or of the intestine, causing pressure on the orifice of the bile duct; it is quite unjustifiable under these circumstances, as statistics have shown that the danger of such a proceeding is very great, seven out of eight of Murphy's cases dying. The parts are exposed as described above, the gall-bladder and duodenum are brought into contact, and a lateral anastomosis made by means of a Murphy button, or by simple suturing; but Murphy's method is undoubtedly the better.

Cholecystectomy, or removal of the gall-bladder, may be necessary for traumatic lesions, and also for malignant disease. The bladder has to be isolated, and may then be cut away, the divided end of the duct being secured by a double row of sutures.

Affections of the Pancreas.

The pancreas is an organ which rarely calls for the attention of surgeons, and only a few conditions need be mentioned.

Wounds of the Pancreas occur, but are so often associated with damage to neighbouring important tissues that they seldom need treatment *per se*. Prolapse through an abdominal wound has been recorded in a few cases, the organ having been almost entirely separated from its connections; however bruised or damaged, its total extirpation must never be resorted to, since diabetes is certain to follow; it should therefore be carefully purified and replaced.

Acute Purulent Pancreatitis is almost invariably a result of infection from the intestine, or from neighbouring parts. It produces symptoms of deep suppuration with excruciating pain, probably from implication of the cœliac plexus, and often causes death from purulent peritonitis. A pancreatic abscess may be opened from the front, but the greatest precautions must be taken against infecting the peritoneal cavity. The stomach is drawn up, and the surgeon burrows through the omentum between it and the transverse colon. A lumbar counter-opening for drainage can be made by the side of the first lumbar vertebra; but it must be remembered that both the aorta and vena cava, and the root of the superior mesenteric vessels, lie behind the gland.

Cysts of the Pancreas have been observed and treated in so many cases since 1887 that their characters are pretty clearly known. Simple complete obstruction to the duct has been proved experimentally not to be a sufficient cause for the disease; some pathological condition of the epithelium must also be present, preventing the reabsorption of the retained secretion. The fluid within is usually turbid and brownish from admixture with blood, odourless, and with a fairly high specific gravity; it is of an alkaline or neutral reaction, and contains albumin, but no urea or bile; it is capable of peptonizing albumin, of emulsifying fat, and converting starch into sugar. The cyst can be felt as a rounded, tense, fluctuating or elastic swelling, placed deeply in the abdomen, immoveable, and perhaps transmitting the aortic pulsation. The stomach lies directly in front of it, as may be made evident by distending it with gas. It is usually a disease of middle life, occurring most frequently in men; emaciation is not marked, although a good proportion of the fatty food passes away in the motions; the skin is often dirty, earthy, and unhealthy-looking. A hypodermic needle settles the diagnosis. Treatment consists in laying the cavity open, evacuating its contents, and draining it, the surgeon finding his way to the cyst between the stomach and transverse colon. A large tube is inserted, either through the front or from the back, by the side of the vertebræ. The skin around usually becomes irritated by the discharge, owing to a process of digestion. The prognosis with such treatment is very good, Treves having collected fifteen cures out of sixteen cases thus dealt with.

Carcinoma of the Pancreas is met with either as a primary growth, or secondary to a similar disease of the pylorus. In one or two cases removal has been undertaken with success, although an exact diagnosis was not arrived at before the operation. Sarcomata and other tumours are very rare.

Affections of the Spleen.

Rupture of the Spleen occurs as a result of injury, causing great shock, pain in the left hypochondrium, and internal hæmorrhage, usually to such an extent as to prove rapidly fatal. In less severe cases the blood collects in the left loin, and gravitates towards the pelvis, the right loin being often kept clear by the position of the mesentery. Laparotomy should be undertaken wherever practicable, and, if much damaged, the organ is removed, the splenic vessels being secured by ligature; the results of such treatment have been most satisfactory. In a few cases it has been possible to stop the bleeding by inserting a gauze tampon, which is removed in a few days.

Abscess of the Spleen may develop in the course of pyæmia, or follow an injury, especially if associated with a lesion of a neighbouring coil of intestine. The symptoms are merely those of deep suppuration in the left hypochondrium, and the abscess may either find its way externally, or burst into the peritoneal cavity. It may be opened and drained with the same precautions as for any other intraperitoneal collection of matter, and the results hitherto obtained have been encouraging. In pyæmia the disease is often fatal before the local phenomena are recognised.

Floating Spleen is occasionally congenital, but more commonly acquired in consequence of tight lacing, injuries, or the presence of tumours. It may be known by the existence of a moveable intra-abdominal swelling, whose shape is that of the spleen, and having a notch in its anterior border; its size also increases after meals. It may be so displaced as to lie in the right iliac fossa, or even in the pelvis, and then has a long narrow pedicle which has, in a few cases, led to torsion and strangulation of the organ. Splenectomy was formerly the best treatment, if the displaced organ caused discomfort or pain; it has been found possible, however, to fix it, and several successful cases have now been recorded. *Splenopexy*, as the operation is termed, is best undertaken by preparing a bed for the organ outside the peritoneum in the loose cellular tissue beneath the floating ribs on the left side. The spleen is then slipped through a small hole specially made for the purpose in the peritoneum, and secured by stitches, which pass through its capsule and anchor it to the under surface of the diaphragm.

Tumours of the Spleen are met with either in the form of a general hypertrophy, as in lymphadenoma or malaria, or as new growths, such as cysts (hydatid most frequently), or secondary carcinoma or sarcoma. The spleen also becomes enlarged in lardaceous disease, rickets, and many of the general fevers. An enlarged spleen constitutes a swelling which extends downwards from the left hypochondrium towards the umbilicus, the notch being felt anteriorly. The condition is recognised by the constant absence of intestine in front of it, by the resonant note obtained in the flank, by its mobility with respiration, and occasionally by its increased size after meals. The treatment, where advisable, consists either of splenectomy, or, in the case of cysts, of incision and drainage.

Splenectomy, or extirpation of the spleen, has been undertaken for a variety of conditions, and its value and position, as a surgical procedure, are now pretty well established. For traumatic lesions it is both safe and justifiable. For primary hypertrophy, and for malarial enlargement, it may be performed if serious discomfort is being caused, and cannot otherwise be remedied. If drainage fails to cure cysts, excision may be performed. If malignant disease is diagnosed sufficiently early, the organ may be removed. Splenectomy for leucocythæmia is absolutely unjustifiable, all the cases operated on having died. The *operation* is performed through any suitable incision of sufficient length. The peritoneum having been opened, the organ is carefully examined, and if extensive adhesions are present, the surgeon will be wise to desist, since fatal hæmorrhage is very likely to result from any attempt to break them down. If the organ is freely moveable, it is carefully drawn out of the abdomen; the pedicle being isolated, and secured temporarily by pressure forceps. It is then cut away, and the pedicle tied after transfixion with silk ligatures, the ends of which are cut short and returned into the abdomen.

General Remarks on Abdominal Operations.

Before concluding this chapter, it seems desirable to add a few remarks dealing generally with the subject of abdominal operations. Formerly they were of rare occurrence, and perhaps this was as well, since septic peritonitis frequently followed. At the present time no competent operator hesitates to open the abdomen whenever the opportunity offers, and the death-rate from preventible causes has been steadily diminishing. The peritoneum, which formerly the surgeon dreaded to touch, is now one of his best friends, if properly treated. Attention to minute details is essential if good results are to be obtained, and the following are a few points which may prove of service to those aspiring to success in this important branch of work.

The patient should be carefully *prepared*, when circumstances permit, by regulating the diet and bowels for some days previously, so that the intestinal canal shall be as free from organisms as possible; a course of internal antiseptics, such as salol, calomel, β-naphthol, may be advisable. If there seems a likelihood of streptococcal infection, it may be well to immunize the patient to the action of such organisms by the previous injection for a day or two of a sufficient dose of antistreptococcic serum, as suggested by H. E. Durham; 10 c.c. given twice or thrice a day for two or three days will suffice for this purpose. No food should be allowed by mouth for some hours, and immediately before being placed on the table the bladder should be emptied. If it is expected that the proceeding will be protracted, it is advisable to give a rectal injection of warm saline solution, or of beef-tea and brandy, half an hour beforehand, and possibly a hypodermic injection of strychnine (gr. $\frac{1}{100}$).

The patient should be warmly wrapped up and protected from cold, no unnecessary exposure being allowed. Chloroform is the best anæsthetic to employ in all abdominal cases, and the more complete the anæsthesia, the less the shock. Intraperitoneal operations are not painless, as has been often stated, for although the visceral peritoneum is not acutely sensitive, yet the parietal layer is, and any handling of this structure gives rise to pain, and necessarily to increased shock if the patient is conscious.

The skin of the abdomen, the hands of the surgeon, and the instruments, are rendered aseptic in the usual way, special attention being directed to the cavity of the umbilical cicatrix. As soon, however, as the peritoneum has been opened, all strong antiseptics must be discarded, since they are likely to irritate this delicate membrane, thus doing more harm than good. Warm sterilized salt solution is the best fluid to employ for irrigating the serous cavity, or for washing out sponges, swabs, or cloths. If sponges are employed, they should be counted previously, and again before closing the abdomen.

Parietal Incision.—Formerly, whenever practicable, the incision was made in the middle line through the linea alba, in consequence of the facts that there is less bleeding in this situation, that all parts of the abdomen are easily accessible from it, and that the wound is more rapidly closed. It has been found, however, that ventral hernia is a not uncommon sequela, and hence the general practice at the present time is to make one's incision in any suitable place, and preferably through vascular structures such as muscle, retaining the linea alba for cases where drainage of a septic focus has to be maintained. Even in such operations as ovariotomy, where the middle line gives the best access, it is wise to go through the rectus a little to one side of the centre rather than through the linea alba itself. The linea semilunaris, again, is a bad situation for an incision, since the traction of the muscles which are inserted into its outer side is so great that hernia is very likely to follow. On the other hand, care must be exercised not to place the incisions too near the bony margins of the abdominal cavity, or subsequent manipulations may be hampered by the rigidity of one side of the wound.

The muscles should be cleanly and neatly divided, and it is wise to see that all bleeding is stopped before opening the peritoneum. Directors are best avoided, since they are very likely to wound the serous membrane, and are quite unnecessary in skilled hands. A small hole should be first made in the peritoneum, through which a blunt-nosed pair of forceps is inserted, and by lifting these up and allowing the blades to separate slightly, an exceedingly convenient and safe substitute for a director is obtained. If a long incision is required, the left index and middle fingers are passed through this opening; the intestines and omentum are thus kept out of the way, the peritoneum being well raised, and divided by scissors to the required extent.

The intestines must be most carefully guarded during the intraperitoneal portion of the operation, as if they are exposed to the air the endothelial lining is quickly shed, and adhesions may form from without, whilst bacterial invasion may be predisposed to from within. A series of cloths wrung out of warm sterilized salt solution must be kept wrapped round them by the assistant, and no unnecessary handling should be permitted.

Closure of the Wound.—A careful toilette of the peritoneum must be undertaken before the abdomen is closed. All blood-clot should be removed, sponges counted, and, if there has been any extravasation of infective material, it is well to wash the site of operation with sterilized salt solution at a temperature of about 108° F., a proceeding which may considerably assist in minimizing shock. Many different methods of closing the parietal incision have been adopted, but perhaps the best consists in securing the serous and muscular coats by one series of deep stitches either of purified silk or of silkworm gut, which remain buried, and then in dealing with the skin by means of a continuous suture, which is subsequently removed. There is no advantage in taking up each of the layers separately, and the integrity of the abdominal cicatrix is increased by leaving all the deeper stitches *in situ.*

Drainage is not usually called for in abdominal operations. If the surgeon is careful in his manipulations, and avoids measures which are likely to lead to subsequent oozing, the peritoneum may be closed with safety. Where an inflammatory focus has been opened, or when adhesions likely to bleed have been divided, or raw surfaces left such as occur after enucleating a parovarian cyst from the broad ligament, some means should be provided whereby any considerable effusion of fluid can escape. It is found that the method of capillary drainage by means of gauze is the best that can be employed for blood or serum. Ordinary indiarubber tubes are liable to become blocked by portions of the intestine protruding into the lateral openings, whilst glass tubes, such as Keith's, are unyielding, and fail to accommodate themselves to the sinuosities of the regions needing drainage. Strips of aseptic gauze are therefore inserted like a lampwick, and along these, by capillary action, the effusion finds its way into the general dressing placed over the wound. Of course a certain amount of adhesive inflammation follows, and therefore the wick should be as small as possible, consistent with efficiency, and changed or removed at the end of forty-eight hours.

After-Treatment.—After the completion of the operation, the patient is replaced in bed, with the head low. If restless and irritable, a small dose of opium may be administered, but the less the better, since it induces intestinal paresis, and this in turn assists bacterial invasion from the gut. No food is allowed to enter the stomach for twenty-four hours, although the mouth may be washed out with warm water or with still lemonade, and nutrient enemata administered every four or six hours. The great essential is to avoid vomiting, and this is best accomplished by a complete temporary cessation of stomach-feeding. At the end of twenty-four hours, if all is going well, a little fluid nourishment may be given, and this is gradually increased. The bowels are left to nature, and unless constipation persists for some days no aperient is necessary.

If peritonitis is threatening, the patient complains of abdominal pain and distension, whilst flatulence and vomiting are distressing symptoms. Under these circumstances the administration of a smart saline purgative may stop the process by re-establishing peristalsis, removing bacteria and their products, and lessening the vascular tension. Failing this, the outlook is grave, though in some cases it may be justifiable to reopen the abdomen, wash out, and drain.

CHAPTER XXXI.

HERNIA.

By the term **Hernia** is meant the protrusion of some viscus from its normal situation through an abnormal opening in the walls of the cavity within which it is contained. This may affect not only the abdominal viscera, but also such structures as the brain and lungs, giving rise to conditions which we have already described. In this chapter we merely deal with hernia as met with in connection with the abdomen.

The most common **Situations** at which hernia occurs are those spots where the parietes are weakened by the transmission of such structures as the spermatic cord and round ligament (inguinal hernia), or at the entrance of the crural canal, where the main vessels of the leg pass under Poupart's ligament (femoral hernia), or at the umbilicus (umbilical hernia). Viscera may, however, protrude through the obturator foramen, sciatic notch, the diaphragm, and in various other situations.

Ætiology.—A great many conditions may be associated, directly or indirectly, with the production of a hernia. They may, however, be described for practical purposes under two main headings —the congenital and the acquired.

Congenital Causes are rather predisposing than exciting in nature, and must be looked for amongst the many malformations and conditions of imperfect development to which the abdominal parietes and contents are liable. The following are the most important of these: (*a*) The non-obliteration of the funicular process of peritoneum, which in the male precedes and accompanies the testicle on its progress downwards from the abdominal cavity to the scrotum, and in the female passes along the round ligament. The so-called congenital inguinal hernia results from this, although it must be remembered that the rupture does not necessarily show itself at birth, and, indeed, may not appear till after puberty, the term being therefore a misnomer. In females under the age of twenty-five, hernia into the canal of Nuck, as this peritoneal tube is called, is the most frequent variety met with. (*b*) The late descent of the testis, whether it finds its way into the scrotum or not, is usually associated with the formation of an inguinal hernia of the congenital type. (*c*) Inherited weakness of the abdominal muscles and parietes, with unusual patency of the rings, will certainly predispose to this condition, and, moreover, there is no doubt as to the tendency of hernia to run in families. (*d*) Abnormal length of the mesentery or omentum has also been looked on as a causative factor; but, although it may have some influence when other conditions are present, it can *per se* have but little effect. (*e*) Congenital phimosis, by inducing forcible acts of micturition, acts as an exciting cause. (*f*) Congenital apertures occur in the linea alba or linea semilunaris, especially opposite one of the muscular intersections in the rectus, and through these one form of ventral hernia may develop. (*g*) The umbilicus is sometimes imperfectly developed at birth, permitting the viscera to protrude into the base of the umbilical cord (congenital umbilical hernia). (*h*) The diaphragm is also occasionally defective, allowing the stomach or other viscera to find their way into the thoracic cavity.

Acquired Causes.—Hernia may result from any condition which tends either to weaken the abdominal parietes, or to increase the intra-abdominal pressure. Thus, all violent exercise, especially when of an intermittent nature and accompanied by excessive straining, as in lifting heavy weights, may determine its occurrence, and the more so if the individual is forced to maintain the upright position, or wears tight bands or girths round the abdomen. Pregnancy stretches the abdominal walls, and parturition, by inducing violent muscular contraction, may originate a rupture, either through a split in the linea alba or through the crural canal. Prolonged and severe bronchitis also favours the occurrence of a hernia by the increase of intra-abdominal pressure due to coughing; whilst the straining to pass water in cases of enlarged prostate or stricture may act in a similar manner. Chronic constipation is a frequent factor in its production, especially if the patient makes use of a closet with a high seat, whereby the inguinal canals are left unprotected; in uncivilized races, where defæcation is performed in the squatting posture, the lower part of the abdomen is supported by the flexed thighs, and hernia is very uncommon. Patients with weak and bulging inguinal regions may with advantage use a low commode. In old people, an additional cause may be found in the slipping downwards of the mesenteric attachment, causing the intestines to occupy the lower part of the abdomen rather than the upper. This is possibly due to weakening or relaxation of the unstriped muscular tissue which normally exists behind the peritoneum, and passing from the posterior abdominal wall to the base of the mesentery; it is sometimes called the *muscle of Treitz*.

Structure.—A hernia consists of a sac and its contents, the sac being formed of peritoneum, perhaps thickened by additional coverings, derived from the abdominal parietes, and the contents being the protruded viscera.

The *sac*, or peritoneal investment of an acquired hernia, is in the early stages funnel-shaped, small, and thin, being derived from that portion of the serous membrane which normally lies over the hernial aperture. As the rupture increases in size, the sac becomes larger, partly as a result of the stretching of that portion of the serous membrane already protruded, and partly by the drawing down of fresh membrane from the neighbourhood; in the groin this is derived rather from the iliac fossa than from the anterior abdominal wall. The sac is described as consisting of two portions—the neck and the fundus. The *neck*, at first relatively large and open, gradually becomes narrowed, and is generally thickened from the irritation to which it has been exposed, either from the wearing of a truss or from the pressure of the contained viscera. The body, or *fundus*, varies much in size and shape, and may undergo considerable alterations in structure. (*a*) Although at first easily replaced, the sac itself soon becomes *irreducible* from adhesions to surrounding parts, though it can still be readily emptied of its contents. (*b*) *Inflammation* may occur as a result of injury or pressure, constituting a form of localized peritonitis. If this is of a chronic type, the sac becomes thickened and opaque, with dilated vessels coursing over it, as seen especially in old irreducible umbilical herniæ. Acute or subacute inflammation is also met with, resulting in the formation of adhesions between its inner wall and the contained viscera, or between the opposite sides of the sac if no other structures interpose. Natural cure of a hernia may in this way be occasionally produced by adhesions forming across the neck of the sac, or by an adherent plug of omentum, thus occluding the communication with the peritoneal cavity. The lower portion of the sac may in a similar way be shut off from the upper, either by a band of adhesions or by a septum of adherent omentum; this isolated cavity is sometimes the seat of a serous effusion, known as a *hydrocele of a hernial sac*. (*c*) Hæmorrhage into the sac wall may result from violence, and will cause it to become much thickened, and even pigmented and leathery in appearance.

The *coverings* of the sac are indurated in old-standing cases, and matted together in such a manner as to render it impossible to recognise the constituent parts. This is specially noticeable at the neck of the sac, where their union with surrounding structures is often such as to constitute an important predisposing element in the production of strangulation. The opening through which the hernia protrudes loses its characteristic features and shape, being enlarged, more or less circular, and displaced so that an oblique passage, such as the inguinal canal, becomes straight, the internal abdominal ring lying almost immediately behind the external.

Contents.—Any viscus in the abdomen may be found in the sac of a hernia, except, perhaps, the pancreas; as a rule, however, one finds only small intestine or omentum.

An *enterocele* is the name given to a hernia containing some portion of the bowel. It is at first reducible; but the gut may become adherent, either to the sac or to some other contained structure, and is thus rendered irreducible. It may also participate in an inflammatory condition of the sac; whilst, if irreducible, obstruction may ensue from impaction of its contents, and if its vessels are constricted strangulation may supervene. For a description of these conditions, see p. 927. The small intestine is much more frequently involved than the large gut. The amount of bowel protruded varies from a few inches to several feet.

If omentum is found in a hernial sac, the condition is known as an *epiplocele*. As long as it remains reducible, it is likely to retain its normal texture; but when large in amount, and especially if irreducible, it becomes thickened, brawny, and matted together to such an extent as almost to constitute a solid tumour; it is often the seat of an excessive deposit of fat, and in consequence of this overgrowth, it may become irreducible, even when no adhesions are present. Serous cysts sometimes develop within it as a result of effusion between opposed surfaces. In some cases openings are found in it of sufficient size to allow the gut to pass through and become strangulated. When omentum and bowel are present in the same sac, the condition is known as an *entero-epiplocele*.

Much discussion has been caused by the occasional presence of the *cæcum* in a hernial sac. It was formerly supposed that this viscus was only partially surrounded with peritoneum, and hence it was maintained that when found in a hernial sac the peritoneal investment was incomplete. It is now, however, universally acknowledged that the cæcum generally has a complete serous covering and usually a mesentery, so that it is freely moveable; consequently it may pass into a hernial sac in the same way as any other moveable part of the intestine, and several instances are on record in which it has been found in an inguinal hernia on the left side. On the other hand, a few indisputable cases have been related in which the serous envelope was incomplete in a so-called 'cæcocele.'

The *bladder* may be associated with a hernial sac in two distinct ways, and usually in the inguinal region. (*a*) The fundus may be dragged downwards by the traction of the peritoneum, where the hernia has attained a colossal size. There is then only a partial peritoneal investment, the bladder lying outside the sac, and being adherent to it. Considerable irritability of the viscus is induced, and, owing to stagnation of urine in the displaced part, a phosphatic concretion may form therein, and such has even been removed by incision through the scrotum. (*b*) Occasionally a saccule of the outer wall of the bladder becomes adherent to the peritoneum, and is drawn down by it into the inguinal canal; its presence may be suspected if a small hernia is associated with much vesical irritability. Such a protrusion consists merely of thickened mucous membrane and submucous tissue, and is devoid of muscular fibres; it is very liable to be laid open in the operation undertaken for the radical cure. If such an accident happens, the opening must be at once closed by sutures, which should not penetrate the mucous membrane, otherwise phosphatic concretions may form on the portion of suture exposed, and cause subsequent trouble.

Loose foreign bodies, somewhat resembling marbles in size, are occasionally, but very rarely, met with in hernial sacs. They are derived from the detachment of one or more of the appendices epiploicæ, which subsequently become enlarged from a deposit of fibrin induced by movement in the peritoneal cavity, and may even calcify.

Signs and Symptoms.—The characteristic features whereby a hernial protrusion is recognised consist in the presence of a rounded or pyriform swelling, in one of the normal or abnormal situations already mentioned, which increases in size when the patient stands, coughs, or strains, having, as it is termed, 'an impulse on coughing.' If intestine is present it may be possible to obtain a tympanitic note on percussion, whilst the tumour feels tense and rounded, and on pressure slips back into the abdomen with a distinct gurgle. Various dyspeptic phenomena, and perhaps colicky pains, may be noticed. An omental hernia feels soft and doughy, has a less distinct impulse, or even none, on coughing, and is replaced without a gurgle; it is dull on percussion. When allowed to reappear, it does so slowly without any sudden impulse, the omentum insinuating itself gently down the inguinal canal, and gradually distending the sac.

The **Treatment** of hernia, whether palliative by means of trusses, or radical by means of operation, differs so widely in the different forms, that it will be better to discuss that for each variety separately.

Special Forms of Hernia.

Inguinal Hernia.—The term **inguinal hernia** is limited to those conditions in which a protrusion occurs into the inguinal canal, and, if allowed to progress, finally makes its way through the external abdominal ring. If it extends into the scrotum, it is termed *complete*, or scrotal; whilst if it does not pass beyond the external abdominal ring, it is known as a *bubonocele* or incomplete inguinal hernia. The neck is always in relation with the deep epigastric artery, and the structures of the cord are either spread out over the sac or are in close proximity to it. In the early stages, the pubic spine can be felt to the outer side of the neck of the sac; but as it increases in size it lies over the spine, which cannot be felt without pushing the hernia upwards and inwards.

Two main **varieties** of inguinal hernia are described, viz., the oblique and the direct.

An **Oblique Inguinal Hernia** (Fig. 311) is one which passes down the whole length of the inguinal canal, entering at the internal and emerging at the external abdominal ring; the deep epigastric artery is thus placed to the inner side of the neck. During its passage through the canal every form of oblique hernia pushes before it and becomes covered by structures representing the various layers of the abdominal parietes. Hence, in cutting down on such a sac, the surgeon will divide, in addition to the skin and subcutaneous tissues, (*a*) the intercolumnar fascia, derived from the transverse fibres of the external oblique which pass across the external abdominal ring; (*b*) the cremasteric muscle and fascia, representing and extending from the internal oblique; (*c*) the infundibuliform fascia derived from the fascia transversalis; and (*d*) finally a layer of subserous tissue varying in thickness, and closely surrounding the peritoneal sac. In practice, the surgeon does not attempt to recognise these different coverings, the only one of importance being the cremasteric, the muscular fibres of which are often evident, and serve as a useful landmark.

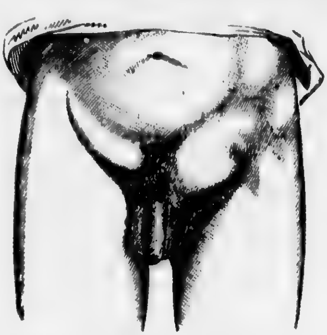


FIG. 311.—DOUBLE OBLIQUE INGUINAL HERNIA.

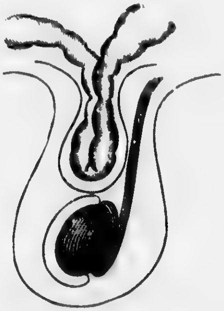


FIG. 312.—DIAGRAM OF ACQUIRED INGUINAL HERNIA, SHOWING SEROUS SAC WITH INTESTINE COMING DOWN TO THE TOP OF THE TESTIS.

There are three different forms of oblique inguinal hernia, viz., the acquired, the congenital, and the infantile or encysted.

1. An *Acquired Inguinal Hernia* (Fig. 312) is one in which the sac consists entirely of peritoneum protruded from within the abdomen. It gradually increases in size, and finds its way along

the cord to the scrotum. The sac usually extends as far as the head of the epididymis, but if of large size it may overlap the testicle, which lies behind it. The structures of the cord are frequently spread out over the sac. In old-standing cases the internal ring is dragged downwards and inwards, and tends to lie behind the outer, and thus it is often difficult to make out whether any particular hernia is direct or oblique.

2. *Congenital Inguinal Hernia* (Fig. 313) is due to non-closure of the funicular process of peritoneum, which passes down to the scrotum with the testicle, and is usually completely obliterated except below, where it forms the tunica vaginalis. As already mentioned, the hernia does not necessarily appear in infancy, its occurrence being often delayed until puberty, or when the patient has to undertake heavy work. This form of hernia is much more frequently met with on the right side of the body, owing to the fact that the right testicle descends into the scrotum at a later date than the left. It is always characterized by becoming complete at once, and even acute strangulation may immediately follow.

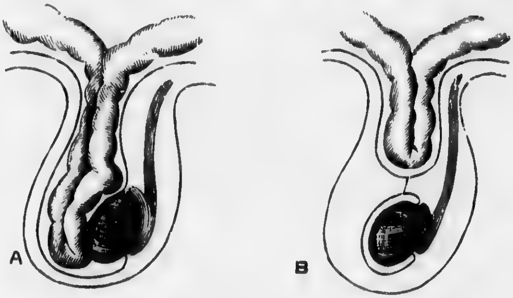


Fig. 313.—Congenital Inguinal Hernia.

A, Vaginal variety; B, funicular type.

In the majority of instances the patent funicular process is continuous with the tunica vaginalis, and the protruded viscera lie in contact with the testis, and somewhat obscure it; this is known as a *congenital vaginal hernia* (Fig. 313 A). Less frequently the funicular process is patent only as far as the head of the epididymis, being shut off from the tunica vaginalis. The hernia under such circumstances exactly resembles the acquired variety, being unrecognisable from it except by the fact that it becomes complete at once. It is termed a *congenital funicular hernia* (Fig. 313 B).

In every case of congenital hernia the structures of the cord are spread out over the sac, and more intimately adherent to it than in the acquired form. Phimosis is usually associated with this condition in young boys.

3. The *Infantile* or *Encysted Hernia* is one occurring in individuals in whom the funicular process, although shut off from the abdominal cavity above, remains patent below, communicating with the tunica vaginalis, which cavity extends, in consequence, as high as the inguinal canal (Fig. 314, A). The hernia has a distinct sac, which passes down behind the open process, or invaginates it (Fig. 314, B and C). It cannot be recognised except on operation, when the surgeon is apt to open the cavity of the tunica vaginalis, which, though reaching upwards, does not communicate with the general peritoneal cavity; on removing or displacing this, the true sac of the hernia is found behind it. This is not so likely to occur at the present day, when the high incision is made.

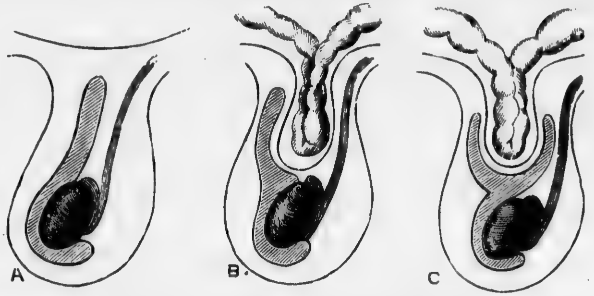


FIG. 314.—INFANTILE INGUINAL HERNIA.

A, Prehernial condition with tunica vaginalis extending upwards to inguinal canal; B, hernial sac coming down behind tunica; C, sac invaginating the tunica vaginalis.

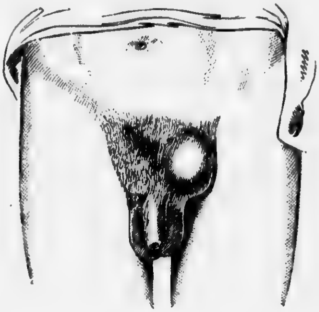


FIG. 315.—DIRECT INGUINAL HERNIA.

A **Direct Inguinal Hernia** (Fig. 315) is one which, though passing through the external abdominal ring, has only travelled through a portion of the inguinal canal; it is never congenital, and usually smaller than the oblique type. The neck lies to the inner side of the epigastric artery, which is often arched very distinctly over it, passing also along its upper wall. The hernia traverses the space known as Hesselbach's triangle, which is bounded internally by the outer border of the rectus muscle, by the deep epigastric artery externally, and by Poupart's ligament below (Fig. 316). The obliterated hypogastric artery passes across this space in a direction parallel to its outer border, dividing it into two parts, and according to whether the hernia protrudes through the inner or outer segment, it is known as an internal or external direct hernia (Fig. 316, 3 and 2). The spermatic cord usually lies to the outer side of a direct hernia, and its constituent elements are never spread out over the sac as in the oblique form.

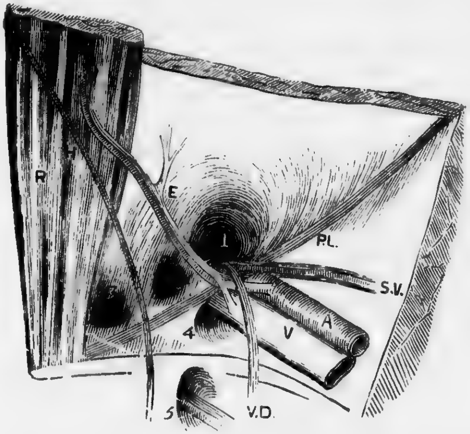


FIG. 316.—ABDOMINAL WALL FROM WITHIN, TO SHOW HERNIAL APERTURES.

A, V, Femoral artery and vein; S V, spermatic vessels; P L, Poupart's ligament; V D, vas deferens; E, epigastric artery; R, rectus abdominis; H, obliterated hypogastric artery; 1, internal abdominal ring; 2 and 3, sites of external and internal direct hernia in Hesselbach's triangle; 4, crural ring for femoral hernia; 5, obturator foramen and vessels.

The **External Direct Hernia** is very similar in nature to the acquired oblique form, except that it is placed to the inner side of the deep epigastric artery, and pushes in front of it the transversalis, instead of the infundibuliform, fascia. It lies to the outer side of the conjoined tendon, and has a less complete covering of the cremaster muscle.

The **Internal Direct Hernia** issues from the abdomen to the inner side of the obliterated hypogastric artery, rupturing or pushing before it the conjoined tendon, which in such a case is poorly developed. The coverings are the same as for the external variety.

Interstitial Hernia is the name given to a condition in which an inguinal hernia does not follow its usual course, but develops in some abnormal relation to the abdominal wall. Three varieties are described: (*a*) Where a sac exists between the transversalis fascia and the peritoneum (*intraparietal* variety), either with or without a hernia in the usual position; in the former instance one form of 'hernia en bissac' is produced. This abnormal pocket of the sac is found either between the symphysis pubis and the bladder (hernia inguinalis ante-vesicalis), or it extends outwards towards the iliac fossa (hernia inguinalis intra-iliaca). As no external swelling is caused by this condition, it is usually impossible to recognise its existence prior to operation; occasionally it is the cause of a continuation of the symptoms of strangulation, when apparently successful taxis has been performed, owing to the strangled bowel being pushed backwards from the superficial into the deeper portion of the sac. (*b*) An abnormal expansion or bulging of the sac is situated between the internal and external oblique muscles (*interparietal* form). A swelling is thus produced in the region of the inguinal canal, covered by the external oblique aponeurosis, and tending to spread upwards and outwards parallel with Poupart's ligament. It may be due to a septum across the sac at the level of the external abdominal ring, formed either by adhesions or by a mass of adherent omentum. The usual downward course of the hernia is thus prevented, and the sac yields laterally, above the site of the obstruction, and passes between the muscles. (*c*) The hernia escapes as usual from the external abdominal ring, but travels outward along Poupart's ligament, somewhat simulating a femoral hernia (*extraparietal* variety). This form is generally associated with late descent of the testis, and a contracted state of the scrotum, so that it is easier for the hernia, which is always of a congenital type, to pass into the thigh, and be guided by the fascia in the direction indicated; in a case of this character operated upon a few years back, the testicle was found lying close to the anterior superior iliac spine. There is no difficulty in recognising such a condition.

The **Signs** of an inguinal hernia do not require much special notice here, as we have already described (p. 909) the general clinical features of a rupture. In the early stages, where merely a bubonocele exists, a fulness is noted in the course of the inguinal canal, which increases when the patient coughs; it is best detected by a finger passed through the external ring into the canal. When it descends into the scrotum, the swelling increases in size from above downwards, and in the oblique variety is continuous with the fulness in the inguinal canal. The structures of the cord are masked by the presence of the hernia, but the testicle is to be more or less distinctly felt at the lower and back part of the swelling. When of the direct variety, the cord lies to the outer side, and although the hernia can be felt projecting from the external ring, it passes directly backwards, and there is no fulness along the course of the canal.

Inguinal hernia is usually met with in the male sex, the oblique variety being more common in the young, and the direct in elderly patients. In the female sex it is rare, except in girls and young nulliparous women; in such cases it is almost always congenital, passing into the labium, but rarely attaining any considerable size.

The **Diagnosis** of an inguinal hernia is usually a tolerably simple matter if it is uncomplicated by any other condition. It may, however, be very difficult, and in old-standing cases it is practically impossible to distinguish the oblique from the direct. There is a considerable variety of conditions for which it may be mistaken, and these are best considered in two groups:

1. Whilst the hernia is still incomplete and in the bubonocele stage, it has to be distinguished from the following: (*a*) *Encysted hydrocele* of the cord, which is recognised by its smooth globular outline and tense walls; the impulse on coughing is less distinct, and, although freely moveable in the canal, it cannot be entirely reduced into the abdomen, whilst the characteristic gurgle of a hernia is absent; traction on the testis, moreover, fixes the tumour, and renders it immobile. (*b*) A *chronic abscess* originating in the abdominal parietes, or within the abdomen or pelvis, will sometimes point through the external abdominal ring. In such cases, although there is a distinct impulse on coughing, and although the swelling is reducible, it has not the definite outline and characteristic sensation of a hernia, being usually soft and fluctuating. Other evidences pointing to the existence of the original disease may also assist in determining the nature of the tumour. (*c*) *Enlarged glands in the groin* which have become adherent to the external oblique are sometimes mistaken for a hernia, owing to the fact that on coughing a distinct impulse is communicated to them; it is, however, merely heaving in nature, and not expansile, whilst on digital exploration of the inguinal canal the absence of a hernia may be readily ascertained. (*d*) A *testicle retained in the inguinal canal* is recognised by that side of the scrotum being empty, and on pressing the swelling testicular sensation may be elicited. The rounded upper end of the swelling can often be detected. (*e*) *Tumours consisting of fat or other tissues* are occasionally seen in the inguinal canal, but are characterised by the strict limitation of their upper border, and usually by the absence of a distinct impulse on coughing. On the other hand, as described elsewhere, a mass of fat simulating a lipoma is sometimes present, resulting from a protrusion of the subperitoneal tissue, a hernial sac being found embedded in its interior. (*f*) *Hæmatocele of the cord* is recognised by a history of injury, the presence of pain and ecchy-

mosis, and the absence of an impulse on coughing, whilst reduction is impracticable.

2. *When the hernia extends into the scrotum*, less difficulty is experienced in its diagnosis. By examination of the cord immediately outside the external abdominal ring, all purely scrotal swellings, such as a hydrocele or sarcocele, are readily eliminated, since in them the cord can, in the early stages, be felt perfectly free. A varicocele can also be similarly recognised from an omental hernia by the condition of the cord in its upper region; whilst if the patient is made to assume the recumbent posture, the swelling disappears in each instance, but if a finger is placed firmly over the inguinal canal so as to prevent any protrusion of omentum, and he is then directed to stand up, the swelling immediately reappears if it is venous in character. To the practised finger, the diagnosis is never a matter of difficulty, since the enlarged veins of a varicocele and omentum are not at all similar to the touch, the veins moving freely under the finger 'like worms in a bag.' When, however, a hernia is associated with a hydrocele or sarcocele, a little more care is necessary in order to distinguish between the two swellings.

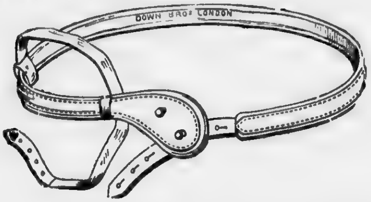


FIG. 317.—INGUINAL TRUSS. (DOWN BROTHERS.)

The **Treatment** of inguinal hernia is either palliative by means of trusses, or radical.

Palliative Treatment.—Many different forms of *trusses* have been introduced in order to prevent the descent of a hernia. No one form is capable of dealing with every case, but the truss must be applied with care, so as to suit the special needs of the particular patient. It is impossible to describe a tithe of the varieties which have been suggested, and hence we must refer our readers to special works on the subject. Suffice it to indicate the essentials of a good truss. It should consist of a pad kept in position over the hernial aperture by a steel spring; it must fit the patient accurately, resting behind on the middle piece of the sacrum, and passing laterally midway between the crest of the ilium and the top of the great trochanter. If the hernia is unilateral, the spring ends on the sound side just behind the anterior superior spine, and is prolonged anteriorly into a leather thong or cross-strap, which is secured to a stud on the pad. To prevent it from slipping up, an under-strap passes from the sound side close behind the anterior superior spine along the fold of the nates to the inner side of the thigh, being fixed finally by a second stud on the pad. This may be rounded or oval in shape, and usually consists of soft iron covered with cork, but polished vulcanite, wood, or an india-rubber cushion filled with air, water, or glycerine have been employed instead; it should be well padded with leather, and the strength of the spring must be so adjusted as to retain the hernia under all conditions of strain to which it may be subjected, but without the use of undue force. In the earlier cases of oblique hernia, the pad should rest rather over the inguinal canal than over the external abdominal ring, the object being to restore the valve-like action of the canal by approximating its sides. In a direct hernia, the pad must be applied directly over the opening. If such an apparatus is properly adjusted and continuously worn, a cure is sometimes established in the course of a year or two, and in cases of congenital hernia in children a cure may be confidently expected if the mother or attendants of the child conscientiously carry out the necessary details. If the hernia is once allowed to slip down, even after six or twelve months' treatment, all the previous good will have been undone.

In infants, an efficient support is afforded by a skein of wool (specially known as 'fingering'), divided at one end, so that when placed round the body the cut ends of the skein are passed through the loop, forming a knot over the inguinal canal, which acts as the pad of a truss. The cut ends are now passed under the perineum, and tied to the transverse portion behind (Fig. 318). This apparatus is changed night and morning when the child is bathed, and also, if need be, at shorter intervals, the mother being previously instructed as to how to support the hernia whilst the apparatus is being removed. In addition to such truss pressure, it is important to remove all causes of intra-abdominal tension, as by circumcision, where phimosis is present, or by regulating the bowels.

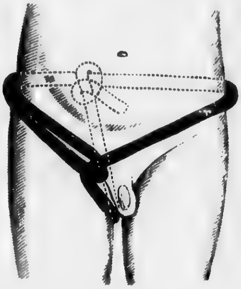


FIG. 318.—WOOL TRUSS FOR TREATMENT OF HERNIA IN CHILDREN.

The **Radical Cure** of inguinal hernia is an operation to which much attention has been directed of late years, since its value was brought prominently before the profession by the late Professor John Wood and others. It is very largely employed at the present day, although there are still surgeons who only advocate its use under exceptional circumstances, appealing to the frequent recurrence after operation as an argument against its adoption. Whilst fully admitting that recurrences are more frequent than they should be, we look on them as either being due to an error of judgment in the selection of the cases for operation, or as resulting from imperfect technique or from inefficient after-treatment.

The selection of cases for an operation of this type, which is not an essential, but only a desirable means of treatment (or, as it is sometimes termed, an *opération de complaisance*), is a matter requiring considerable judgment and discrimination. In those whose occupation does not subject them to heavy strain or exertion, and who possess a hernia which, under ordinary circumstances, is easily commanded by a suitably applied truss, no operation is absolutely necessary; although if the patient is made to understand that thereby he may be freed from the irksomeness of wearing a truss, and from the risks of possible strangulation, it may be undertaken at his request. If, however, the subject is a labouring man, exposed to injury and strain, and who may find it difficult to provide a suitable series of trusses, the operation should always be undertaken unless distinctly contra-indicated by a general inherited weakness of the abdominal muscles, or by such constitutional disease as precludes all unnecessary operative interference. Again, in cases of extensive irreducible hernia, the return of large masses of intestine which have lain for years in the hernial sac so increases the intra-abdominal tension as frequently to determine recurrence locally or elsewhere, and are therefore unfavourable for operative interference. As to the earliest period of life at which an operation may be performed with safety, it is perhaps on the whole better to delay it until the age of three, owing to the risk of infection of the wound from the constant saturation of the dressings with urine.

A considerable number of different operations have been described and practised by various surgeons; in all probability many of them are unnecessarily complicated, and can only be briefly alluded to. The plan we employ is practically the same as that usually associated with the name of *Mitchell Banks*. The instruments required are scalpels, forcipressure forceps, artery forceps, retractors, transfixion needle, curved hernia needles, and scissors. The operation may be described in the following stages: (1) The pubic region having been previously shaved and thoroughly purified, an incision is made in the direction of the inguinal canal and cord, about 2½ inches in length, its centre being a little above the external abdominal ring. This is carried through the skin and subcutaneous tissues until the structures of the cord are reached, the superficial external pudic artery being necessarily divided *en route*; the pillars of the ring and the external oblique aponeurosis are then clearly defined. (2) The sac has now to be identified; if the hernia is one of old standing, or contains adherent omentum or intestine, it is readily recognised; but if it is thin, empty, and of recent formation, its identification may be a matter of some difficulty. The structures of the cord are spread out over the fingers, the coverings divided, and the white convex border of the fundus of the sac looked for; in the case of a bubonocele it is necessary to slit up the external oblique in order to find it. It is sometimes necessary to induce vomiting by titillation of the fauces, in order to cause the hernia to protrude. (3) If the sac is empty, it is freed from its connection with the structures of the cord without opening it, and isolated as far as the internal abdominal ring, as indicated by a collar of fatty subperitoneal tissue surrounding the neck. If the hernia is irreducible, the sac is laid open, its contents freed from adhesions, and the intestine returned into the abdomen, whilst omental tissue is removed, and the stump replaced. The greatest gentleness must be employed in dealing with the intestines; if a considerable amount is present, it must be surrounded by a cloth wrung out in warm lotion (carbolic acid, 1 in 60). Adhesions are carefully divided either by the finger or between ligatures; if closely adherent to the sac, it may be necessary to leave a small portion of this attached to the gut, which is then returned. Omentum, whether adherent or not, if present in the sac, should be removed, as the elongated fringes are very liable to contract adhesions to the abdominal parietes, and subsequently produce mischief. In removing omentum, it is not advisable to encircle the mass with a single ligature, as the vessels are less securely commanded, and a pocket or pucker may be produced, leading later on to internal strangulation. Small portions, including one or more of the larger vessels, should be taken up one after another, and tied separately. The protruded mass is then cut away below the ligatures, and the stump replaced after seeing that no bleeding point remains unsecured. The sac, being now emptied, is isolated as far as the internal ring. (4) The neck is then transfixed as high as possible, and ligatured with sterilized silk, and the sac cut off below the ligature, the stump retracting well above the internal ring. (5) The opening in the abdominal parietes is closed by a row of sutures passing through the conjoined tendon on the inner side, and through Poupart's ligament on the outer, the stitches being all placed in front of the cord; on the outer side the close proximity of the iliac vessels must not be forgotten. Sufficient room should be left for the passage of the cord through the lower part of the external abdominal ring; if it is unduly constricted, atrophy of the testis results. (6) The wound is closed by a continuous suture, and usually no drainage-tube is needed.

After-treatment.—The patient is placed in bed with the head low, and the knees slightly flexed over a pillow. The wound, as a rule, does not require dressing for seven or eight days, when, on removal of the stitches, it should be found completely healed, if asepsis has been maintained. The patient should turn to the opposite side in order to pass water, and the greatest care must be taken to prevent the dressings becoming soiled. Occasionally retention of urine follows this operation, necessitating the use of a catheter. The recumbent posture should be maintained for three weeks, and nothing but the lightest work undertaken for at least six weeks, and no violent effort until six months after the operation. Under such circumstances the use of a truss is unnecessary, and, indeed, we consider that it is undesirable, as its pressure is liable to produce atrophy of the newly-formed cicatricial tissue. When, however, the abdominal walls are congenitally weak, or if unfortunately the wound has suppurated, the deep stitches coming away, it is advisable to use a light truss for a time.

The treatment of *congenital hernia* differs in no particular from that already described, except that the sac must be divided below as well as above, and the lower opening secured by suture or ligature, so as to close the cavity of the tunica vaginalis. The operation often proves difficult owing to the intimate adhesions between the sac and the structures of the cord, and it is sometimes impracticable to completely isolate the neck of the sac.

The chief *modifications* of this operation are the following:

(*a*) *Ball's Operation* consists in freeing the peritoneum on the inner aspect of the internal abdominal ring, and then the sac, after being isolated, is twisted into a tense cord, so as to throw the serous membrane into a series of folds, thereby producing a prominence internally rather than an infundibuliform depression. To prevent untwisting, a ligature is tied around it as high as possible, and it is also transfixed below the ligature by a thread, the ends of which are passed through the abdominal parietes.

(*b*) In what is known as *Barker's Operation* the neck of the sac is isolated, ligatured, and divided, the fundus being left *in situ*, whilst the thread used in tying the neck is employed as the first suture to close the deep part of the canal; by this means it is hoped that the neck of the sac will be displaced, and hence more satisfactorily occluded. It is very doubtful, however, whether this really occurs.

(*c*) *MacEwen's Method* consists in opening up the inguinal canal by dividing the aponeurosis of the external oblique, freeing the under surface of the abdominal parietes for some distance around the internal abdominal ring, and in placing therein as a pad across the internal opening of the canal the sac, which has been previously isolated and threaded through with silk in such a way as to throw it into folds. The silk thread is then passed by means of a needle through the abdominal parietes on either side, and fixed by traversing the aponeurosis of the external oblique once or twice. The canal is subsequently closed with sutures, which are passed in such a way as to draw up Poupart's ligament over the arched fibres of the internal oblique.

(*d*) In *Bassini's Operation* the external oblique aponeurosis is divided, so as to expose the lower arched fibres of the internal oblique. The sac is ligatured and removed, as also any varicose spermatic veins, and the structures of the cord displaced and drawn forwards and outwards through the wound in the external oblique. The canal is completely closed behind the cord by a row of sutures, securing the lower arched fibres of the internal oblique to the under surface of Poupart's ligament. The cord is then replaced, and the divided fibres of the external oblique are sutured over it. We consider this operation an exceedingly valuable one.

(*e*) *Halsted's Operation* is much the same, except that the fibres of the internal oblique are also divided at the outer margin of the internal ring, and the cord displaced upwards and outwards through this opening, so that at the spot at which it pierces the abdominal parietes it may be surrounded by muscular fibres. The canal is then closed as in the former operation, whilst the external oblique is also sutured behind the cord, which is thus made a subcutaneous structure. We see no special advantage to be gained by this departure from Nature's method of conducting the cord and its structures through the abdominal wall in an oblique direction.

(*f*) *Kocher's Operation.*—The sac is completely isolated up to the internal abdominal ring. An opening is then made through the external oblique aponeurosis and the muscular fibres of the internal oblique well above and to the outer side of the inguinal canal; through this the sac is drawn. It is then twisted up into a cord and sutured down as an external splint or pad in front of the canal.

Many other proceedings have been advocated and practised, but we cannot devote more space to the subject. The original and simplest operation (Mitchell Banks') amply suffices, in our opinion, to meet the requirements of ordinary cases, reserving Bassini's method for exceptional instances.

Recurrence after Operation is unfortunately met with only too frequently, and, as already stated, may be due partly to an injudicious selection of cases, partly to errors of technique, and in part to a faulty after-treatment, the patient being given too much liberty at too early a date. In connection with this we would especially emphasize the necessity for isolating the sac as far as possible, since otherwise the infundibuliform opening at the top of the closed peritoneal canal is certain to persist. Another not uncommon cause of recurrence is septic contamination of the wound; if the deep stitches are not involved, no great harm is done, but whenever they have been removed or come away it is wise to use a truss subsequently as a precautionary measure. Again, the mere restoration of a mass of intestine or omentum into the abdominal cavity may suffice to raise the intra-abdominal pressure, and thus predispose to a recurrence; hence the importance of removing as much omental tissue as possible in all bad cases. Relapses may also be due to splitting or tearing of the tendinous structures around either by the mere passage of the needle, or by the traction induced by tightening the sutures; indeed, it is often the case that a hernia originally oblique may after operation be followed by one that is direct, and probably from this cause.

Whenever it appears likely that such an accident may occur, a truss should be ordered. If, however, a hernia has developed, a second operation should be performed, if the condition of the abdominal parietes warrants it.

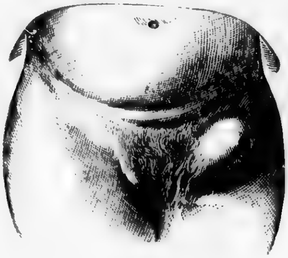


FIG. 310.—FEMORAL HERNIA.

Femoral Hernia.—A femoral hernia is one which, travelling down the crural canal, presents at the inner and upper part of the thigh through the saphenous opening. It occurs most commonly in women, on account of the greater expansion of the iliac crests allowing increased space beneath Poupart's ligament, and especially in those who have borne children. During parturition the inguinal regions are in a measure protected, and hence inguinal hernia is rarely caused in this way. The crural canal constitutes the inner compartment of the femoral sheath, a space usually occupied by fatty cellular tissue, lymphatic vessels, and perhaps a lymphatic gland. It is about ¾ inch in length anteriorly, and 1½ inches along its posterior wall; it is closed above by a thickened portion of the subserous cellular tissue known as the septum crurale, and its lower end is formed by the saphenous opening, and closed by the cribriform fascia. Hence a femoral hernia, as it passes downwards, receives the following coverings: (*a*) peritoneum; (*b*) subserous cellular tissue, including the septum crurale, a layer sometimes known as the fascia propria, and occasionally represented by a thick fatty envelope; (*c*) the anterior layer of the femoral sheath, derived from the fascia transversalis; (*d*) cribriform fascia; (*e*) subcutaneous tissue; and (*f*) skin. In its passage it is situated immediately internal to the femoral vein, and pressure upon this may produce œdema of the leg, whilst Gimbernat's ligament lies to the inner side of the neck of the sac. The spermatic cord or round ligament passes just above and internal to it, but on a superficial plane, whilst the epigastric artery is not very far from the outer side of the neck. Occasionally the obturator artery arises from this latter vessel (once in three and a half subjects);

it either passes to the inner side of the neck of the sac along the border of Gimbernat's ligament (once in seventy-five times), but more commonly runs between the neck and the femoral vein. When once it has emerged from the saphenous opening, a femoral hernia tends to pass upwards and outwards along Poupart's ligament towards the anterior superior iliac spine, being guided by the attachment of the deep layer of the superficial fascia; when of large size, it may extend considerably above the level of Poupart's ligament. Femoral herniæ are less likely to contain omentum than the inguinal variety: a portion of the ileum is most often present, but occasionally the ovary or Fallopian tube may be found in the sac.

The **Signs** of a femoral hernia are very characteristic. A swelling with an impulse on coughing, and more or less reducible, forms on the inner side of the thigh, its neck or aperture of communication with the abdomen lying to the inner side of the femoral vessel, and to the outer side of the pubic spine, which can always be felt (Fig. 319). There is usually but little difficulty in making a **diagnosis**, although occasionally considerable care is needed, and especially in distinguishing it from the following conditions: (*a*) From *inguinal hernia*, which is more common in young males, its neck occupying the inguinal canal, and the saphenous opening being free; whilst it is also above and internal to the pubic spine, and above Poupart's ligament at its point of exit; it tends to pass downwards into the scrotum, or in females into the labium. Femoral hernia, on the other hand, usually (but not invariably) occurs in women over twenty-five years of age; the inguinal canal is free, whilst the neck is in the situation of the crural canal, below and external to the pubic spine and below Poupart's ligament; moreover, it travels upwards and outwards, the labium being unaffected. (*b*) An *enlarged lymphatic gland* over the saphenous opening may simulate this condition very closely; but the absence of impulse on coughing and of the usual hernial signs is generally sufficient to distinguish it; when, however, the hernia is purely omental and irreducible, the impulse is so slightly marked that correct diagnosis in a stout woman is often difficult without an exploratory incision. (*c*) A small *lipoma* in the canal somewhat resembles a hernia, but the limitation of the tumour, its greater mobility, and the absence of an impulse on coughing should suffice to prevent any mistake. (*d*) A *psoas abscess* pointing at the saphenous opening resembles a hernia in the existence of a reducible swelling with an expansile impulse on coughing. It is distinguished from it by the facts that there is no gurgle on reduction; that the abscess, as it passes under Poupart's ligament, lies to the outer side of the vessels; and that distinct fluctuation occurs between the swelling in the saphenous opening and the tumour, which can always be felt in the iliac fossa; the characteristic signs of spinal caries are also usually present.

(*e*) In *varix of the saphena*, if a pouch or so-called ampulla forms close to its entrance into the femoral vein, it may be mistaken for a femoral hernia on account of the marked impulse on coughing, and because the swelling disappears on assuming the recumbent posture. It is, however, usually associated with the signs of varix below, and by the fact that, although pressure is made over the upper part of the crural canal after the vein has been emptied, the swelling regains its ordinary size when the patient stands up.

Treatment.—When reducible and of small size, a femoral hernia may be treated by the use of a *truss*, similar in nature to that used for an inguinal hernia, except that the pad extends somewhat lower, so as to maintain pressure along the course of the canal. A badly fitting truss may compress the femoral vein, and lead to œdema of the leg.

Operative Treatment is undertaken either for the relief of strangulation, or if a radical cure is desired as an *opération de complaisance*. The remarks already made as regards the cure of inguinal hernia, and the general principles there enunciated, apply also to this variety. Two main methods of operating are employed: (*a*) The sac is exposed by a vertical incision along the course of the crural canal, emptied of its contents by reduction of intestine and removal or reduction of omentum, and cut away after transfixing and tying the neck. The deep ring is then commanded by a suture passed vertically between the fascia over the pectineus and the inner end of Poupart's ligament; this must, however, not be tied too tightly, for fear of constricting the femoral vein. (*b*) Watson Cheyne recommends that a portion of the pectineus muscle should be dissected up, and fixed in the crural canal by means of sutures; and he claims thereby to have had very satisfactory results. The same precautions as to after-treatment must be adopted as in inguinal hernia.

Umbilical Hernia.—Three different forms of umbilical hernia are described.

1. **Congenital Umbilical Hernia**, or **Exomphalos**, is an exceedingly rare condition, due to imperfect closure of the abdominal walls, as a result of which the intestine is not entirely withdrawn into the abdomen at birth, but is found in a cavity at the base of the umbilical cord, which is bulbous and enlarged. If the condition is overlooked, it may be included in the ligature with which the cord is tied, and fatal strangulation, or at the best a fæcal fistula, will result. If left untreated until the cord has separated, the peritoneal cavity will be laid open, and septic peritonitis ensue. The only treatment is immediate laparotomy, reduction of the gut, and closure of the umbilical opening by sutures.

2. The **Umbilical Hernia of Infants and Young People**, or, as it is commonly called, 'starting of the navel,' is due to weakness of the umbilical cicatrix, which yields before the intra-abdominal

pressure. Its occurrence is often determined by chronic constipation or phimosis, necessitating continual straining in order to evacuate the bowels or bladder. The condition rarely persists till adult life is reached, and it is readily amenable to treatment. This consists in regulating the bowels, the performance of circumcision, if necessary, whilst the local condition is dealt with by a pad and strapping applied to the umbilicus. In persistent cases it may be necessary to lay the sac open and remove it, suturing the parts together, as described in detail below.

3. The so-called **Umbilical Hernia of Adults** is usually due to a protrusion of omentum or intestine through an opening in the linea alba, either immediately above or below the umbilicus, the former being the more common. It occurs most frequently in women who have borne children, being sometimes due to actual rupture of the linea alba and separation of the recti muscles. In such cases it is possible that the peritoneum is also torn, and the intestines extravasated, as it were, beneath the skin. A peritoneal sac is, however, usually seen, but in old-standing cases it is extremely attenuated, and so adherent to surrounding parts as to be unrecognisable, whilst the contents may be matted together in an almost inextricable confusion. In such old-standing cases obstruction is very liable to ensue, and if combined, as is not uncommon, with a subacute form of inflammation, it may even run on to strangulation. Moreover, the skin over the tumour becomes stretched, atrophic, and not unfrequently ulcerated, so that perforation may threaten. The hernia is often lobulated in character, and a considerable deposit of fat may sometimes be found surrounding it.

Treatment.—When of large size, and occurring in stout individuals, it should be supported by a bag truss, whilst the patient is placed on such dietetic and hygienic measures as shall assist in the reduction of excessive corpulency. In favourable cases, operative treatment can be undertaken. A vertical incision is made over the site of the tumour, and to effect this without wounding the subjacent gut, it may be advisable to pinch up the skin on either side, and cut it by transfixion. The sac is then opened, the incision being enlarged, if necessary, so as to allow the contents to be drawn aside and the opening in the abdominal wall exposed. When the intestine has been reduced and omentum removed, the sac is dissected up to the margins of the opening into the abdomen, which is usually small in size and circular in shape, whilst the edges are firm and thickened. The sac may now be cut away close to the opening, and all bleeding-points secured. The aperture is then closed in the following way: Several deep transverse sutures are passed through the whole thickness of the abdominal wall on each side, and tightened after a row of interrupted sutures has drawn the peritoneal surfaces into contact. By this means the circular aperture is obliterated and the margins united in the median line. The external wound may now be closed, any redundant skin being cut away; it is usually safer to insert a drainage-tube in the more extensive cases. Some surgeons recommend that the fibrous margins of the deep opening should be freely removed by dissection before the passage of the sutures, so as to expose the fibres of the recti muscles, and permit of their approximation after the peritoneum has been turned in; the suggestion is a good one, since the union of healthy vascular tissue must always be more favourable than that of two anæmic cicatricial edges. Silkworm gut may be used with advantage in these cases for the deep sutures, since it remains unabsorbed.

A **Ventral Hernia** is the term used in describing any protrusion occurring at some spot in the anterior abdominal wall other than those already mentioned. Several forms may be met with:

1. It not uncommonly consists of a protrusion of subserous fatty tissue through a congenital or acquired opening in the linea alba, lineæ semilunares, or lineæ transversæ, especially at the junctions of the former and latter. They are more common above than below the umbilicus, and if, as not unfrequently happens, the fatty tissue proliferates, a localized tumour resembling a lipoma is produced, and goes by the name of a 'fatty hernia of the linea alba.' A portion of peritoneum is drawn through the opening into the centre of these masses when they have persisted for some little time, and a true hernia is thus induced. A similar condition is met with in the inguinal and crural regions, and probably most of the cases described as lipomata in these parts are of this nature. Considerable pain and abdominal disturbance (vomiting, colic, etc.) accompany almost every movement of the body, being caused partly by the traction of the peritoneum, partly by the constriction of the neck of the sac against the sharp edges of the small opening. *Treatment* consists in the removal of the projecting mass, care being taken not to include any viscera in the suture with which the base is surrounded. The stump is pushed back into the abdomen, and the opening closed by deep sutures.

2. After operations involving the division of the abdominal parietes, ventral hernia may be caused by the yielding of the cicatrix, especially if the wound suppurates, and the deep stitches come away or are removed, or if the opening is left patent for the purpose of draining an intra-abdominal abscess. *Treatment* of such cases consists in dividing the skin and subjacent fibrous tissues, defining and refreshing the edges of the parietal wound, and drawing them together with buried sutures. The peritoneum need not always be opened in such a procedure, but it is sometimes wiser to do so. Especially is this the case when a ventral hernia forms after an operation for suppurating appendicitis; the appendix is then rarely dealt with at the primary operation, and the surgeon may rightly take the opportunity of removing it during the operation required for the cure of the hernia.

A **Lumbar Hernia** is a condition of considerable rarity, in which the abdominal viscera protrude by the side of the erector spinæ, coming to the surface between the latissimus dorsi and the external oblique, in the space known as Petit's triangle. The ordinary signs of a hernia are present, and with a little care the condition is readily distinguished from a lumbar abscess. *Treatment* may be conducted along the same lines as for a ventral hernia.

A **Diaphragmatic Hernia** is rarely recognised *ante-mortem*. A few cases of strangulation have, however, been diagnosed. It is usually congenital in origin, arising from imperfect development of one or both halves of the diaphragm; it is most common on the left side. It may, however, result from traumatic lesions, such as stabs, involving the diaphragm. The transverse colon or stomach generally protrudes into the thorax, and there is usually no peritoneal sac. *Treatment* is impracticable in the majority of instances, although one or two cases of traumatic hernia have been successfully operated on.

Obturator Hernia consists in the protrusion of intestine through the upper part of the thyroid foramen. It is not often recognised in the living, except when strangulated, and even then, unless of considerable size, it is likely to be overlooked. It has, however, been diagnosed by the fact that, in addition to the usual general signs of strangulation, there was a sense of deep resistance and of fulness close to the origin of the adductor muscles; whilst pain was referred down the obturator nerve to the inner side of the knee. Rectal or vaginal examination may throw some light on the nature of the case. *Treatment* has generally been confined to cases of strangulation, and in such an incision is made over the inner aspect of Scarpa's triangle, and the pectineus divided or displaced. The sac when found should be opened, and strangulation relieved by cutting upwards, the obturator vessels being usually situated below the neck of the sac.

Other forms of hernia, *e.g.*, **pudic**, **pudendal**, **vaginal**, **sciatic**, etc., have been described, but are so uncommon that they need no special mention.

Abnormal Conditions of Herniæ.

Irreducibility of a Hernia is generally due to the presence of adhesions, either between the contents and the sac, or between the contents themselves, which are thus united into a mass too large to pass through the aperture of communication with the abdomen. This is often associated with contraction of the neck of the sac, which arises either from the pressure of an ill-fitting truss or the constant drag of the contents. Overgrowth or an excessive deposit of fat in the omentum may result in irreducibility, whilst cysts may occasionally form, as already described.

The local signs of this condition are very evident, whilst dyspepsia, a sense of dragging, and colicky pains are among the most prominent symptoms.

Treatment.—1. It may sometimes be remedied by *forcible taxis* applied at intervals, between which the patient is kept in bed, and an icebag applied so as to contract the parts; moreover, the patient, if fat, should be carefully dieted. 2. Another plan consists in the use of what is known as the *hinged-cup truss;* the hernia is supported in a suitable leather bag hinged to the lower part of a truss, upward pressure being maintained by means of an elastic spring. By the use of one or other of these plans, reduction may after a time be accomplished; but we are not in favour of any such proceedings, except in large herniæ. 3. In healthy individuals, and if the rupture is not too large, operation is preferable, and much more satisfactory, omentum being removed and adhesions divided, as already described (p. 919). 4. In a few very aggravated cases, it is only possible to support the hernia by an elastic bag.

Inflamed Hernia is one characterized by the existence of a localized peritonitis involving the sac, and perhaps also the contents. It usually arises from injury, such as ill-directed taxis, or from injudicious truss pressure. The symptoms are those of a local inflammation, the part becoming hot, painful, tender, and swollen, and perhaps the skin over it red; this is associated with general fever, malaise, nausea, and vomiting, whilst constipation is also usually present. A condition is thus induced somewhat resembling strangulation; but it is distinguished from the latter by the presence of fever instead of shock, the absence of tension in the sac, and the character of the vomiting, which is not fæcal. The hernia is irreducible, at any rate for a time, probably more on account of the pain, which prevents taxis, than from any mechanical reason, except in old-standing cases where previously formed adhesions exist. Lymph is deposited on the serous surfaces, and this usually leads to the formation of adhesions. Occasionally, where omentum is alone present, an attack of this type may result in a natural cure, especially in the umbilical variety.

The **Treatment** consists in putting the patient to bed and restricting his diet to fluids, whilst hot fomentations are applied to the part. A little opium may also be administered to allay the pain, and possibly the lower bowel emptied by an enema.

Obstructed Hernia is a condition in which the onward passage of fæces through the gut contained in a hernial sac is prevented. It is most frequently seen in the umbilical variety, and is of course irreducible. It is due to an accumulation of undigested food or fæces, the condition being aggravated by the presence of flatus derived from the decomposition of the contents of the bowel. Nausea and vomiting are induced, the latter, however, rarely becoming fæculent, whilst constipation is usually present, although the lower bowel may empty itself and flatus may pass. Locally the tumour becomes distended, but not tense as in strangulation, and a doughy mass, which can be moulded and indented by the fingers, is felt within the sac. There is no tenderness, but the patient usually complains of a good deal of intermittent colicky pain. If unrelieved, a subacute form of inflammation may supervene, and this may pass on to strangulation, and even death.

Treatment consists in the use of copious enemata, and the application locally of an icebag, followed by carefully applied taxis, so as to assist the onward passage of the impacted contents. As soon as the obstruction is overcome, a brisk purge should be administered.

The term **incarceration** is also used to indicate obstruction in an irreducible hernia; but it is somewhat misleading, and should be avoided.

Strangulated Hernia.

A hernia is said to be strangulated when the contents are constricted in such a way as to obstruct and ultimately arrest the flow of blood in the vessels contained therein. Interference with the passage of fæces is not an essential in this condition, since omentum alone may be involved, or the intestine, if present, may only have a portion of its lumen constricted, as in the form known as **Richter's hernia**, or in **Littré's hernia**, where a diverticulum is similarly affected.

Two chief varieties of strangulation are described: those occurring within the abdomen, which are dealt with more fully in Chapter XXXIII., and those which are extra-abdominal; it is only the latter to which we shall now direct attention.

External Strangulated Hernia arises in one of two ways: (*a*) The hernia becomes strangulated immediately after its formation; this is most frequently seen in children or adolescents, the hernia being then of the congenital type. (*b*) In adults it more frequently results from the extrusion of an additional amount of the abdominal contents into the sac, as the result of some sudden violent effort. This condition usually obtains in old-standing herniæ, the neck of the sac having previously become thickened and contracted, either by the pressure of a truss or the irritation of the protruded viscera. The former of these two conditions is usually acute in character, the latter more often subacute.

The site of the constriction is either at the neck of the sac, or in the dense tissues external to it, but occasionally it exists elsewhere. Most frequently the active agent in the strangulation is the thickened sac wall itself; but in femoral and umbilical hernia structures outside the sac, such as Gimbernat's ligament or the linea alba, may be the actual cause of the constriction, whilst it may also be produced by the passage of a coil of intestine under a tight adhesion or through a slit or aperture in the omentum contained in the sac. In those herniæ which become strangulated immediately after their protrusion, the constricting cause is invariably the resistance of the tissues surrounding the opening in the abdominal parietes.

Pathological Phenomena.—The effects of strangulation vary somewhat with the tightness of the constriction. The circulation is seldom entirely arrested at the onset of the symptoms; but the pressure affects first, and more especially, the veins, and later, by the congestion and exudation thus produced, the flow in the arteries is brought to a standstill. Hence the constricted tissues are intensely congested to begin with, and pass over into a state of gangrene with or without an intermediate period of inflammation.

When a *portion of intestine* is strangulated, the following changes manifest themselves in its structure and appearance. At first it becomes of a dusky red, chocolate, or claret colour, owing to vascular congestion; it is thickened and stiff from exudation into its walls, and distended by the formation of gas within its lumen, owing to the arrest of peristalsis and putrefaction of its contents. The surface at first maintains its shiny colour and appearance, but as the exudation from it into the sac increases, the surface endothelium is usually shed. Occasionally some of the superficial capillaries rupture, giving rise to ecchymoses, whilst in rarer instances the congested vessels may completely empty themselves into the sac, which is thus filled with clotted blood, the intestine in consequence becoming lax and yellowish-grey in colour. When the strangulation is relieved in this early stage, the bowel soon regains its former healthy appearance. If inflammation occurs, the surface becomes rough from the deposit of lymph, and entirely loses its shiny and polished surface. Gangrene results partly from the prolonged stagnation of blood, and partly as the effect of the action of the *Bac. coli*, which, as soon as the vitality of the intestinal wall is sufficiently impaired, migrates through it, and by its development produces toxic bodies which still further assist the gangrenous process. As soon as it is established, the intestine turns an ashy grey or black colour, usually at one or more spots which gradually spread, loses all lustre and polish, and after a time becomes soft, lacerable, and offensive. *At the point of strangulation* the gut is completely anæmic and liable to ulceration, which may subsequently result in perforation; adhesions may, however, form between it and the neck of the sac, thus preventing contamination of the general peritoneal cavity. The intestine *above the site of strangulation* becomes paralyzed, and peristalsis is entirely arrested, even in a Richter's hernia. Fæcal material, accumulating and undergoing decomposition, gives rise to a catarrhal enteritis, and even occasionally to stercoral ulcers, which may perforate and cause general peritonitis. In more chronic cases gangrene of the gut may be induced by the pressure of the accumulated contents, and the action of the *Bac. coli*. The portion of the bowel *below the constriction* may be affected in a similar manner, owing to the arrest of the peristalsis, but to a slighter degree.

Omentum when strangulated is at first congested, and of a dark red or purplish colour, and later on infiltrated and matted together. If, however, it has contracted adhesions to the sac, and no gut is present, the trouble may subside, since its vitality may be maintained through the adhesions, and a natural cure of the hernia may result. Where such a condition is not present, gangrene supervenes, and the omentum then becomes ashy grey or brown in colour, and is pultaceous and friable. It does not become offensive unless associated with intestine, as it does not contain any intrinsic source of putrefaction.

The *sac* is usually distended with fluid, which at the commencement is serous in character, and perhaps blood-stained, whilst subsequently it becomes turbid and mixed with lymph; finally it is dark brown or yellowish-green, with a marked and most objectionable odour. Occasionally there is but little or no effusion of fluid, a condition more often met with when intestine is absent from the sac, and only omentum, or some solid viscus, such as the ovary, is present. The serous lining of the sac is but slightly affected in the early stages; as, however, the case progresses to inflammation or death of the contents, it also becomes inflamed, and ultimately gangrenous owing to the action of the *Bac. coli*, which by this time has penetrated to the turbid serum contained within it. The surrounding tissues, including the skin, become œdematous, congested, and crepitant, and, finally, may determine a natural cure by sloughing and the establishment of an artificial anus.

After the relief of strangulation, even if no gangrene has occurred, the patient is not free from risk, owing to changes which may possibly follow the temporary arrest of the circulation. It has been shown by placing a ligature around the ear of a rabbit that the amount of reaction, when the constriction is relieved, varies directly with the tightness with which the ligature has been applied, and with the period of constriction. When applied loosely and only for a short time, the cessation of circulation is followed merely by a transient hyperæmia, but as the completeness and duration of the obstruction are increased, the inflammation becomes more and more intense, and even gangrene may follow. Similar results are met with after the relief of strangulated hernia. In the less severe cases the intestine merely becomes temporarily congested, but in the more acute forms the paralysis of the gut may persist, whilst inflammation, even running on to gangrene, may be produced, either in the strangulated portion or in that immediately above, and thus, although the operation has been skilfully performed, a fatal issue may ensue.

The **Clinical History** of a case of strangulation is, as a rule, so characteristic that there can be but little uncertainty as to the diagnosis. The *general* symptoms are similar to those described at p. 943, as occurring in all cases of acute intestinal obstruction. The patient during some sudden effort notices a severe pain, localized at first to one of the hernial regions, or referred to the umbilicus; this is accompanied by the usual evidences of shock —*i.e.*, he feels faint, the pulse becomes slow and weak, the temperature falls, and the surface is covered by a cold, clammy sweat. This shock is usually not very prolonged, and is quickly associated with or followed by vomiting, at first gastric, then bilious, and finally stercoraceous or fæcal. As this continues, the pain increases in severity, and radiates over the whole of the abdomen, which becomes tense, tender, and tympanitic. Symptoms of exhaustion supervene, caused partly by the pain and vomiting, and partly by the inability to take food; probably the absorption of toxic products from the intestine also assists in its production. Complete constipation is usually present, but the patient may pass flatus or fæces from the lower part of the intestine. The onset of gangrene is usually accompanied by a sudden fall of temperature and a cessation of pain, whilst the pulse becomes weak, rapid, and intermittent, the surface is covered by a cold sweat, the countenance becomes shrunken and drawn (the so-called 'facies Hippocratica'), hiccough follows, and finally the patient dies, usually as a result of toxæmia due to the absorption of products developed either in the bowel wall or sac, or in consequence of acute generalized peritonitis. *Locally*, the onset of the symptoms is associated with the formation of a tumour in one of the usual sites of a hernia, or if already the subject of this condition, the patient may notice that his rupture has suddenly become larger. The swelling is irreducible, tense, extremely tender and painful, and without impulse on coughing. It is hard and rounded if bowel is involved, softer and more doughy to the touch if omentum. When gangrene ensues, the tension within the sac is reduced, pain and tenderness cease, whilst the skin over the tumour becomes dusky, inflamed, and œdematous; finally, evidences of gangrene show themselves externally, the parts becoming dark in appearance, and soft and emphysematous to the touch. If the patient survives, the necrotic tissues separate, and an artificial anus is produced either naturally or through the intervention of the surgeon. Suppuration within the sac is uncommon.

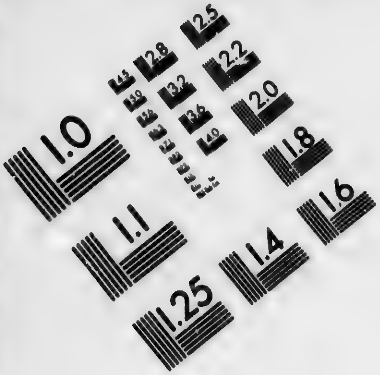
Occasionally, however, cases are met with in which the above described signs are considerably modified, and in one case which we had recently under treatment, the patient complained of no inconvenience beyond slight pain, although incipient gangrene was present; he walked into hospital saying that he never felt better in his life.

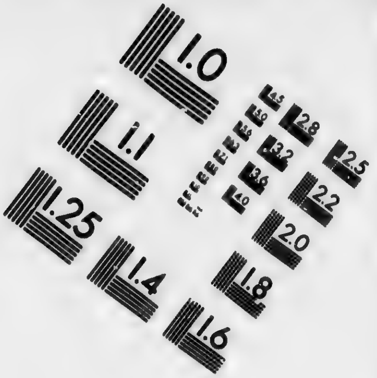
The symptoms arising from strangulation of a portion of the lumen of the intestine (*Richter's hernia*) are somewhat less marked than when a complete loop is constricted. It is usually of the femoral variety, and the ileum is most frequently involved. Less than half the circumference of the bowel is, as a rule, constricted, and in such the obstruction is not always complete at first, flatus and fæces being sometimes passed; but where more than half the circumference of the bowel is engaged, complete obstruction from kinking or paralysis of the gut ensues. The vomiting is less marked than in other cases, and is not so commonly fæculent. The tumour produced is small in size, but tense and tender. Considerable danger arises both from the difficulty experienced in diagnosis, and from the tightness of the constriction, death usually resulting from perforative peritonitis, occasionally due to wounding of the gut by the hernia knife. The mortality in these cases is calculated at 62 per cent., which is in marked contrast with that of about 35 per cent. characteristic of ordinary strangulated hernia.

The occurrence of *strangulation in a pure epiplocele* is very rare, the symptoms vague in character, and the diagnosis often difficult. The presence of a soft, doughy, tender swelling in any of the hernial regions, combined with pain, bilious vomiting, and possibly constipation, is always a significant feature. So long as no kinking of the bowel is caused thereby, the symptoms may remain indefinite, the vomiting never becoming fæcal; but as time goes on, arrest of peristalsis may lead to true obstruction, or even general peritonitis. As already mentioned, strangulated omentum does not *per se* become offensive; but occasionally a neighbouring coil of intestine may be dragged upon, and its circulation disturbed sufficiently to enable the *Bac. coli* to escape, and then it may find its way into the sac, and develop therein its characteristic odour without any serious lesion of the intestine or peritoneum being conjoined.

Treatment consists in relieving the strangulation, either by reducing the contents by taxis, or by operation.

Taxis is the term employed for the manipulation by means of which a hernia is reduced. In cases of strangulation, it must be used with gentleness and great care, owing to the strangulated portion of intestine being congested and easily torn. The patient is laid on a couch with the head supported, and the thighs slightly flexed, so as to relax the abdominal muscles. The fundus of the tumour is then grasped with one hand, and steady pressure employed, having for its object the emptying of the congested bloodvessels, and consequently a diminution in the size of the hernia; the fingers of the other hand manipulate the neck of the sac, in order that the part which has most recently been protruded may be returned first. The direction in which taxis should be performed varies in different cases. In inguinal hernia, it should be directed upwards, outwards, and backwards. In a femoral hernia which has extended beyond the saphenous opening, taxis is first employed downwards and inwards in order to make it re-enter the crural canal, and then finally backwards and upwards, the margins of the saphenous opening being relaxed by flexing and slightly inverting the thigh. In umbilical hernia, the pressure is mainly directed backwards. In all cases, taxis should be employed under an anæsthetic as well as without, since the patient often resists the efforts of the surgeon on account of the pain. Hence, if ordinary taxis is applied for a few minutes (certainly not for more than five) and fails, the instruments required for an operation should be prepared, and the patient placed on the table. Anæsthesia is then induced, and a final attempt to reduce it by taxis undertaken, on the failure of which the operation is at once commenced. The objections to making prolonged efforts at taxis are very obvious, since even if successful one does not know the precise condition of the bowel, whilst considerable injury may result from the injudicious application of force, and the patient loses one of the great advantages of operation, viz., the additional radical cure, which in favourable cases should always be undertaken.





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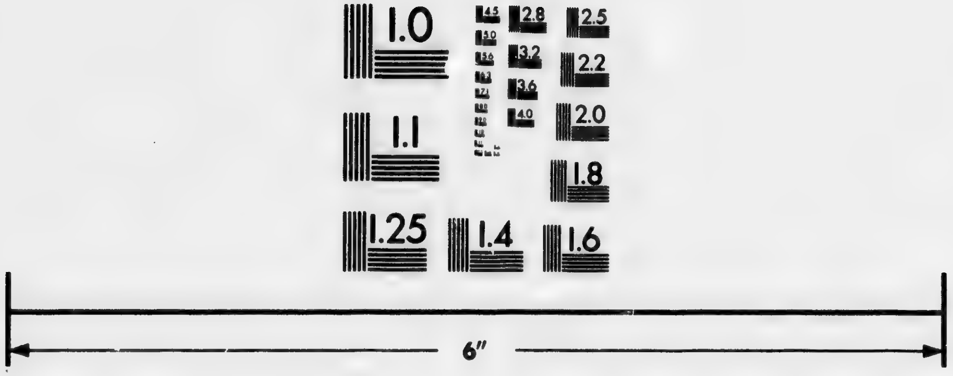

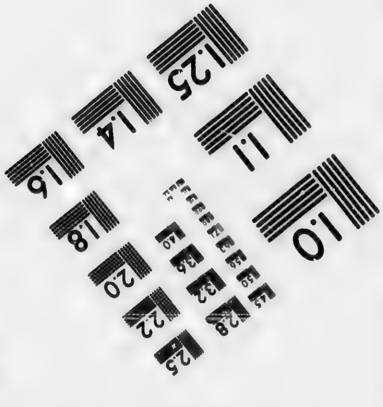

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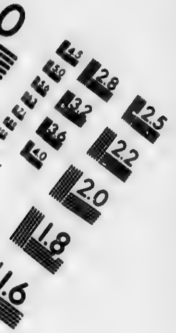
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In some of the slighter conditions of strangulation, and especially if the patient has had similar attacks before which have been relieved without operation, reposition may be induced by applying hot fomentations for half an hour, followed by the use of an icebag, reduction sometimes taking place spontaneously. The heat relaxes the tissues around the neck of the sac, and the effect of the cold is not only to constrict these tissues, but also to induce contraction of the intestinal bloodvessels and muscular structure.

Persistence of Symptoms after apparently Successful Taxis.—It occasionally happens that although the surgeon may have apparently reduced the hernia satisfactorily, the symptoms of exhaustion, pain, vomiting, and constipation persist. Such may be due to a variety of conditions, and considerable judgment is needed in coming to a correct decision in any particular case. The chief causes are as follows: (i.) The vomiting may possibly be due to the anæsthetic, but then does not usually persist for any length of time, and early loses its fæcal character. (ii.) The gut remains paralyzed from the effect of the constriction; inflammation may then supervene, involving either the released coil of gut or the portions above or below it, and perhaps running on to ulceration, perforation, and death from peritonitis or toxæmia. (iii.) The rupture reduced may not be the one which has given rise to the symptoms, an internal hernia, or one in some other region, co-existing. (iv.) The strangulation may have been caused, not by the neck of the sac, but by a slit in the omentum contained in the sac. Reduction in such a case would not relieve the strangulation, the whole mass being returned into the abdomen. (v.) The hernial sac may have a diverticulum or pocket communicating with it at its upper end (intraparietal interstitial hernia), or it may be shaped like an hourglass. It is possible to reduce the intestine from the lower portion of this so-called *hernia en bissac* into the upper pocket, and yet not relieve the strangulation. (vi.) Reduction *en bloc* or *en masse* may occur; in this the sac and its contents are together reduced from its superficial position to the deep aspect of the abdominal parietes, the hernia then lying between the muscular planes or in the subserous areolar tissue, and the strangulation persisting. In such a case the sac sometimes gives way, the intestine and the portion of the neck which compresses it being pushed upwards. When occurring in the inguinal region this is recognised by the persistence of the symptoms, and by the fact that a finger inserted into the canal, which is unduly patent, detects a tense rounded swelling at its upper end.

If a case occurs in which, after an apparently successful taxis, the symptoms of strangulation are still present, a most careful investigation is called for in order to ascertain, if possible, the cause. Thus, the character and frequency of the vomiting must be considered, since, when due to anæsthetics, it usually loses its fæcal character, and is less trying. If the vomiting is associated with a certain amount of local pain, and possibly with some blood-stained diarrhœa or the passage of mucus, the probability is that the coil of gut has been in reality reduced, but has passed on into a state of inflammation. Apart from such indications, the affected region must be thoroughly explored with the finger, so as to ascertain whether any tumour can be felt at the upper or deeper end, as occurs in reduction *en masse*. Should this throw no light upon the case, the other hernial apertures must each in turn be examined, and finally an incision is made over the supposed site of strangulation, and an exhaustive search made for the sac. If no help is thus obtained, the abdomen must be opened, and an internal strangulation sought for. In the inguinal region, all that is needed is to prolong the first incision upwards and outwards; in a femoral hernia, it is perhaps wiser to make a separate laparotomy wound in the middle line, so as to avoid the division of Poupart's ligament; whilst in the umbilical variety, the requirements of the case are met by simply increasing the size of the communication between the sac and the abdominal cavity.

The **Operative Treatment** of strangulated hernia should always be undertaken at as early a date as possible, when once it is certain that the bowel is constricted, and taxis has failed. Nothing can be gained by waiting, whilst even the delay of an hour may make it doubtful whether the result will be successful or not. There is always sufficient time to permit of efficient purification of the parts; a suitable incision is then made down to the sac, which should be recognised by its tense and rounded outline. It is isolated as far as possible from surrounding structures, and then carefully opened. There is usually no risk of injuring the bowel, on account of the fluid poured out into the sac; but if no effusion is present, or if the gut is adherent to the anterior wall, it is more likely to be injured. Having given exit to the fluid from the sac and noted its characters, the surgeon carefully examines the bowel or omentum. The cause of strangulation is then looked for and divided by a special hernia knife, which practically consists of a curved blunt-pointed bistoury, the cutting blade being limited to an extent of about ¾ inch from the blunt end. If such is not to hand, an ordinary curved bistoury will suffice. The index-finger is employed to repress and guard the intestine, and acts better than a director, since intestine is likely to curl up on either side of the instrument, and may thus be injured. The knife is then slipped on the flat under the constriction, and turned so as to divide it; it is better to slightly nick it in two or three places than to incise it by one deep cut, as is often recommended.

The gut is drawn down into the wound, and its condition at the site of strangulation carefully examined. The omentum, if small in amount and recently prolapsed, may be reduced, but it is better practice to remove any congested portion, or that which has evidently been in the sac for some time. The method of its removal has been already described (p. 919).

According to the condition of the intestine, the further steps of the operation are modified as follows:

1. If the gut, though congested, shows no signs of gangrene or perforation, it may be safely reduced. This is not always a matter of ease, owing to the fact that the effusion into its walls has made it stiff and firm. Prolonged and steady pressure with the fingers will, however, sufficiently remove the exudation to permit of its reposition into the abdomen. All manipulation directed to the intestine must, of course, be of the gentlest nature, it being more friable than usual in its congested state.

2. If the gut has been tightly strangled and gangrene is threatening, it may be advisable to resect it at once, the incisions being made well above and below the sites of constriction; the divided ends are united by one of the plans detailed at p. 867. If, however, the bowel is in a doubtful condition, but recovery thought possible, it is gently replaced just inside the abdomen, after freely dividing the constriction, and, if thought advisable, secured there by a stitch, whilst a large drain-tube is inserted. In this way, even if gangrene or perforation occurs, a track is left for the escape of the contents, whilst a localized plastic inflammation will shut off the general peritoneal cavity. A fæcal fistula may in this way form, which often closes spontaneously at a later date.

3. If the gut at the time of operating is evidently gangrenous, the treatment is always a matter of difficulty, and one concerning which very different views are held. Two chief methods have been suggested:

(*a*) The gangrenous loop of bowel is opened, or the perforation, if such is present, is enlarged sufficiently to allow of the entrance of the finger into the lumen of the gut. There should be a free flow of fæces as the result of this proceeding, but if the constriction at the site of strangulation is considerable, a pair of dressing forceps should be passed up the bowel, and the narrowed portion dilated if possible. Failing this, the adhesions which have formed at the neck of the sac must be gently broken through, and the constriction divided; but if this can be avoided, so much the better, since by such means the general peritoneal cavity is exposed to the risk of septic infection. An artificial anus is thus formed through which for a time the patient can discharge the intestinal contents, and unless this desideratum is at once attained, failure is very likely to follow the operation. The wound is left open and a suitable dressing applied, into which the fæces can be received; possibly the best application is a layer of protective with a sufficient hole in the centre to allow the fæces to pass, and then over it a thick layer of tenax.

(*b*) More recently the practice of primary enterectomy with suture of the divided ends has been extensively practised, and with considerable success.

The selection of one of these two plans in any particular instance depends mainly upon the age and condition of the patient. If he is not in a state of profound collapse or exhaustion, the latter should be always practised; but if, as is more frequently the case, symptoms of severe depression are present, the former method should be adopted, the artificial anus being subsequently dealt with as soon as the patient's general condition makes it justifiable, if possible within a week or ten days. The relative value of the two methods cannot be fairly measured by the death-rate, since so many of the cases treated by the formation of an artificial anus are hopeless from the beginning. There can be no question that, with our present methods of intestinal suture, a large measure of success may be expected from the adoption of primary resection in suitable cases.

Having thus dealt with the strangulation, it is advisable to perform a radical cure in uncomplicated cases, so as to prevent any recurrence of the hernia. This is undertaken according to the methods already described, and the external wound subsequently closed and drained.

The **After-Treatment** in cases of strangulated hernia is of the greatest importance. The patient is placed in bed, and absolute quiet is maintained, no food being allowed for twenty-four hours, although a little ice may be sucked or hot water sipped in order to relieve thirst. If there is no pain, opium need not be administered, as it tends to maintain the paralyzed condition of the bowel; severe pain may, however, call for the hypodermic injection of a small dose of morphia. Liquid food can usually be taken at the end of twenty-four hours, and, if the patient's condition remains satisfactory, it is unnecessary to administer any purgative, the bowels often acting naturally; if they remain unrelieved for five or six days, a dose of castor-oil should be given.

Various **Complications** may arise after the operation, needing special notice. (1) *Vomiting* may persist for a time as a result of the anæsthetic. It loses, however, its fæculent character, and may generally be stopped by washing out the stomach or by the hypodermic injection of morphia. (2) The *Paralytic* condition of the gut may remain for some considerable time, causing prolonged constipation. If there is no evidence of inflammatory mischief, it is best treated by the administration of a purgative, or by a turpentine enema. (3) *Acute Enteritis* may arise either in the portion of strangled gut or just above. This is usually evidenced by localized pain, and perhaps the passage of mucus, which may be so abundant as to amount to diarrhœa; the vomiting, moreover, persists, but is no longer stercoraceous. If ulceration or perforation ensues, peritonitis will follow, but whether this occurs or not the case is very likely to terminate fatally from exhaustion. It is best treated by the administration of bismuth combined with morphia, whilst all solid food is interdicted, and stimulants may be freely given. (4) The occurrence of *Peritonitis*, or of a certain amount of peritoneal activity, is inevitable after all cases of strangulated hernia. In most instances it is productive of no harmful results; but where the vitality of the gut wall has been so lowered as to allow of the passage of the *Bac. coli*, or where its integrity has been interfered with by laceration or perforation, an acute form of inflammation is set up which is seldom localized, and rapidly becomes *general*. Lastly, septic infection of the peritoneum may be derived from the external wound, or as a result of local contamination by dirty instruments or fingers. *Treatment.*—As soon as peritonitis threatens, the administration of a smart saline purge is often beneficial, acting by unloading the intestines and encouraging peristalsis. Subsequently opium in carefully regulated doses may be given, whilst nutrition is maintained by enemata, or by small quantities of fluid by the mouth. Distension of the intestine should be prevented, if possible, by passing a long tube, or by giving a turpentine enema; puncturing the distended coils of intestine has been adopted, but is extremely dangerous. The condition is necessarily one of the greatest gravity, and as a last resource laparotomy may be performed, and the peritoneal cavity washed out.

Localized Peritonitis may be looked on as a conservative measure, whereby Nature isolates some focus of danger from the general peritoneal cavity. Occasionally localized suppuration follows as the result of a limited ulceration or perforation of the gut; the pus must then be evacuated at the earliest possible moment, but a fæcal fistula is very likely to follow.

It is impossible to describe in detail every form of strangulated hernia. A few facts, however, must be stated about the more important varieties. In **Strangulated Inguinal Hernia** the constriction most commonly occurs at the neck of the sac, usually close to the external abdominal ring, as a result of the condensation of the surrounding tissues. The signs are usually very characteristic, and the condition can rarely be mistaken. Some difficulty may be experienced in distinguishing it from *inflammation of an undescended testis;* in this, however, there is no persistent vomiting or constipation, whilst the absence of the testis below, and the existence of the peculiar testicular sensation, when the swelling in the canal is compressed, should clear up the case. Occasionally the two conditions may co-exist, and then a correct diagnosis, apart from an open exploration, may be almost impossible. *Torsion of the testis*, and subsequent strangulation of the organ, give rise to a swelling not at all unlike a strangulated hernia, but the absence of constipation and fæcal vomiting should prevent mistakes.

Division of the stricture in the course of the operation is always performed in a vertical direction, the surgeon cutting directly upwards, the reason being that it is impossible in old-standing cases to be certain whether the hernia is oblique or direct, and thus the liability to injury of the epigastric artery is diminished.

In **Strangulated Femoral Hernia** it is more common to find bowel than omentum, and it is in this situation that partial herniæ (Richter's) are most frequently met with. A tense painful swelling is felt, situated in the neighbourhood of the saphenous opening, and the diagnosis from inflamed lymphatic glands and phlebitis of a varicose saphena vein may not be altogether easy, particularly if omentum alone is present. The history of the case, and a careful consideration of the physical signs and symptoms, should generally be sufficient to clear up the diagnosis. The constriction is usually met with opposite Gimbernat's ligament, and to divide it the surgeon must cut directly inwards, so as to incise that structure. The plan already mentioned of nicking it in two or three places, rather than freely dividing it, is especially useful in this situation, on account of the occasional abnormal course of the obturator artery, which is stated to be wounded once in every 150 cases. The accident would be recognised by the occurrence of free hæmorrhage after the use of the hernia knife. In such a case, the rupture is first reduced, the wound enlarged upwards, and both ends of the divided vessel secured, if possible. Failing this, carefully adjusted pressure may be employed.

Artificial Anus is the only means whereby Nature relieves the obstruction due to strangulated hernia. One applies the term to a condition in which an opening into the gut has been produced in such a way that the greater portion of the fæces finds an exit through it. It may arise from the sloughing of the intestine and overlying skin apart from operation; or from the surgeon's interference, either by his opening the gut in mistake for the sac, or by his incising it when gangrenous; or it may slough subsequently, if left *in situ* when gangrene is threatening. If no operation is undertaken, the surrounding parts settle down after a time and heal over, the diversion of the fæces from their natural course becoming more and more complete, owing to the formation of what is known as a *spur* of mucous membrane, which lies across and blocks the entrance to the lower portion of the bowel. This spur arises partly as a result of the kinking of the gut, partly from the intra-abdominal pressure, which pushes the exposed inner wall of the intestine forwards. The effects produced by an artificial anus on the individual vary with the portion of the bowel involved. If the jejunum or upper part of the ileum is thus opened, the patient soon loses ground and becomes emaciated, owing to the escape of the intestinal contents, before the nutritive elements of the food have been absorbed. Eczema of the skin in the neighbourhood is usually produced, resulting from the irritation of the fæces. The artificial anus made in order to prevent the flow of fæces over an ulcerated surface, as in colotomy for rectal cancer, is of quite a different character, since the surgeon desires to establish such an efficient spur as shall prevent all passage of fæces down the lower part of the tube.

The curative **Treatment** of an artificial anus, where desirable, consists in the re-establishment of the lumen of the gut, and the closure of the external wound. To effect this, two chief methods have been recommended: (1) The old-fashioned plan necessitates the repression or removal of the spur as the first stage in the proceeding, whilst the closure of the external wound is effected subsequently. In some cases it may suffice to pass a large rubber drainage-tube into the gut, extending for some inches above and below the opening, stitching it in position for a time by a fine catgut suture, which will be absorbed in the course of a few days, and thus set the tube free, to be subsequently passed *per anum*. The edges of the wound are pared after its insertion, and the opening closed, either by simply bringing the margins together, or by turning in from the neighbourhood, and stitching into position, a reversed pedunculated flap of skin, which exactly fits the opening in the mucous membrane, and with its skin surface inwards. The raw surface of this flap is covered by another raised from the opposite side of the wound, and fixed by sutures with its cutaneous surface outwards. In more chronic cases, Dupuytren recommended that the spur should be destroyed by dragging it outwards and grasping it by an enterotome (Fig. 320), which consists of two blades fitting into one another, which are maintained in apposition by a screw. The portion thus grasped sloughs slowly away, the peritoneal cavity being protected by a plastic inflammation. After destruction of the spur, the external wound may be closed as described above. Such treatment of an artificial anus is tedious and uncertain; whilst even if successful, the patient probably suffers from recurrent colic, owing to the adhesion of the intestine to the abdominal wall, a condition which may also expose him later on to the risk of intestinal obstruction. (2) A much better method of treatment is that by means of an open operation. In this a semilunar incision is made on either side of the artificial anus, by deepening which the peritoneal cavity is freely opened, and the artificial anus, together with the surrounding tissues, can be lifted up, exposing the coil of adherent intestine. This is now clamped above and below, divided as near to the opening as possible, a V-shaped portion of mesentery removed, and the continuity of the intestinal canal restored by some form of enterorrhaphy. It is then returned to the abdomen, and the external wound closed by sutures. In the inguinal and femoral regions it is sometimes impracticable to undertake such an operation, owing to the important nature of the surrounding structures, and then Dupuytren's method may be followed, or a lateral anastomosis established through a separate incision into the abdomen between the portions of intestine going to and returning from the opening; the external aperture is subsequently closed by a plastic operation.

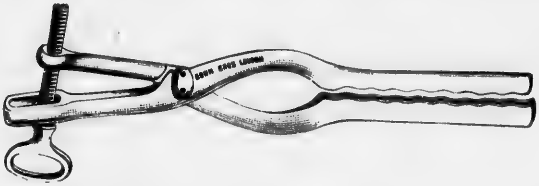

FIG. 320.—DUPUYTREN'S ENTEROTOME. (DOWN BROTHERS.)

Fæcal Fistula occasionally results from a strangulated hernia, owing to a perforative inflammation of the gut after the relief of strangulation, whether at the site of constriction or above or below it, in the latter case arising from a stercoral ulcer. Though the lesion may be intraperitoneal, it by no means follows that general peritonitis need result, since sufficient plastic material may be formed around it to shut off the general peritoneal cavity, and to allow the extravasated contents of the bowel to find their way outwards through a sinuous track to the external wound. It may be some days before any evidence of the existence of this condition appears. Not uncommonly the opening will close naturally as a result of cicatricial contraction, and hence no steps need be taken to deal with it until all hopes of such a result have faded. Where, however, it persists, attempts may be made to close it by injecting stimulating lotions, or by applying the actual cautery to the interior of the fistula; but more frequently an operation to expose, if practicable, the wound in the gut, and to close it by suture, will be called for.

CHAPTER XXXII.

INTESTINAL OBSTRUCTION.[*]

By **Intestinal Obstruction** is meant a condition in which the onward passage of the fæces is prevented. In acute cases it is usually associated with strangulation, owing to the circulation through the vessels being impeded and finally arrested.

Many different types of **classification** of this condition have been suggested, and many of them are more or less valuable. They may be described as congenital or acquired—under the former term grouping together congenital stenosis, congenital adhesions, etc., and under the latter all the ordinary conditions; or they may be divided into classes according to whether the obstruction is due to causes within the gut, to changes in the structure or relative position of the intestinal wall, or to pressure from without. The most useful division is the clinical one, grouping together those cases which present a similarity in the symptoms; and this method will be employed here, the subject being discussed under the three headings—acute obstruction, chronic obstruction, and intussusception.

Acute Intestinal Obstruction.

The following are the chief **Causes** which give rise to this condition:

1. Strangulation by bands or adhesions, or through apertures, etc.
2. Volvulus.
3. The impaction of foreign bodies.
4. Strangulation over a band or acute kinking of the gut, both very rare conditions.
5. Acute intussusception.
6. It may be the termination of a chronic obstruction.

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[*] For much of the material incorporated in this chapter we beg to acknowledge our indebtedness to Mr. Treves' classical text-book on the subject (published by Cassell and Co.), than which nothing better has appeared, and which we have freely utilized.

Paralysis of the gut, such as that induced by acute peritonitis, localized or diffuse, by acute enteritis following the reduction of a strangulated hernia, by a Littré's hernia, etc., gives rise to phenomena of *pseudo-obstruction*, the cause being not so much mechanical as nervous in origin. It will be mentioned again at p. 946.

The **General Symptoms** of acute obstruction are practically identical with those of a strangulated hernia. The patient is suddenly seized with acute abdominal pain somewhat of the nature of colic, and referred to the umbilicus, coming on perhaps during some special effort, *e.g.*, lifting a heavy weight. At the same time he suffers from symptoms of shock, evidenced by a weak pulse, pale face, and cold, clammy sweat, the temperature of the body falling below the normal. The shock is usually recovered from pretty rapidly, but the pain persists, but is liable to exacerbation and intermissions, and soon becomes continuous. Vomiting ensues, being at first limited to the contents of the stomach, but quickly changes to a bilious, stercoraceous, or even fæcal, character. Signs of constitutional depression and exhaustion follow in a short time, the pulse being weak, rapid, and thready, the temperature remaining subnormal (except occasionally after the supervention of peritonitis, when it may rise a few degrees), the face looking pulled and drawn (facies Hippocratica), the abdomen distended and painful. Finally the patient, if unrelieved by treatment, dies, and usually within seven to ten days from the onset, owing to exhaustion or perforative peritonitis. Constipation may be absolute from the first, but at any time the lower bowel may empty itself, and raise false hopes as to the prognosis. The explanation and variation of these symptoms in different cases is given later on.

The Special Forms of Acute Obstruction must now be considered *seriatim*.

1. **Strangulation by Bands or Adhesions, through Apertures, etc.** **Causes.**—(*a*) *Isolated peritoneal bands and adhesions*, the results of old plastic peritonitis, usually of a localized and chronic character. The greatest variety is met with in the appearance and situation of these adhesions; sometimes they are single and cordlike, which is the most common form; sometimes they are broad and membranous, constituting a false ligament; or, again, they may be multiple. The most usual situation is between different parts of the mesentery, or between the mesentery and some other viscus, the cause being either disease of that viscus (usually a pelvic organ or the cæcum) or inflammation of a mesenteric gland with localized peritonitis. Two methods of producing strangulation are met with; either the bowel passes under the arch or loop formed by a short constricting band, and cannot return, or, if the band is long, it may form a loop or noose through which the bowel passes, and so becomes strangled (Fig. 321).

(*b*) *Cords formed by the omentum* result from union between its fimbriated extremities and some part of the viscera or parietes, forming at first a broad band-like adhesion, which is gradually moulded into a rounded cord by the constant dragging and pulling to which it is subjected. They are usually coarser and thicker than those due to peritonitis. The mechanism of strangulation is identical, the noose form being perhaps the more common, since the adhesions are likely to be longer. (*c*) *Meckel's diverticulum* (p. 855) is liable to cause strangulation when its free end becomes adherent either to the parietes or to the viscera; it is attached most frequently to the mesentery of the ileum, and after that to the neighbourhood of the umbilicus. Occasionally the diverticulum ends in a fibrous cord, which may remain fixed to the umbilicus, or floats free in the abdominal cavity, and then later on becomes adherent to some other structure, thus producing a fibrous cord. Strangulation may be effected either by bowel passing under the loop, formed by the adherent diverticulum, or by a loop or noose being developed. (*d*) The *vermiform appendix*, *appendices epiploicæ*, or *Fallopian tubes* may contract abnormal attachments, and thus form arches or loops under which bowel may pass and become strangled. (*e*) *Slits, pouches, and apertures* in the peritoneal investment, whether normal or abnormal, may lead to strangulation. All external herniæ may be grouped under this heading, as also those exceedingly rare conditions known as internal herniæ, in which the abdominal contents find their way into pouches in the posterior wall of the peritoneum, *e.g.*, into the lesser sac of the omentum, or the so-called fossa duodeno-jejunalis. Slits may also be found in the omentum or mesentery, either congenital, traumatic, or the result of operations.

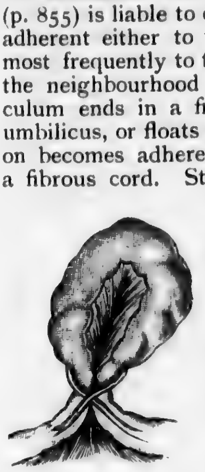

FIG. 321. — STRANGULATION BY BAND. (TILLMANNS.)

Phenomena.—This form of obstruction usually occurs in young people, and is rare after forty; it is very frequently met with, constituting above one-fourth of all the forms of obstruction, and the lower 2 feet of the ileum are the portion of gut more often involved. There is commonly a previous history of peritonitis, but the onset is usually sudden, and the symptoms of strangulation, as detailed above, are of a typical character. The abdomen is flaccid at first, and not tender until peritonitis ensues, on about the third or fourth day. No tumour can generally be felt, and no peristalsis or dilated coils of intestine are to be seen. The average duration is about five to seven days, the patients dying of exhaustion or toxæmia following peritonitis.

2. **Volvulus** is the most common cause of acute primary obstruction of the large intestine. By it is meant a rotation

of the gut upon its own mesenteric axis in such a way as to interfere not only with the passage of the intestinal contents, but also, sooner or later, with the circulation, determining a condition of strangulation. Occasionally a similar result is brought about by the intertwining of one coil with another. The sigmoid flexure is the part mainly affected, although it occurs more rarely in the cæcum or small intestine. In the former situation it is predisposed to by a long narrow sigmoid meso-colon, so that the two ends of the loop are brought closely together; this condition may be of congenital origin, but more usually is due to stretching, resulting from prolonged chronic constipation; a distended sigmoid hanging into the pelvic cavity drags upon and elongates the meso-colon, tending to approximate the two ends of the loop, and necessarily causing a slight obstruction at these spots. Some irregular movement of the gut or of the abdominal walls suffices to cause rotation of the pedicle, and thus brings about the volvulus. When once present, plastic peritonitis soon fixes the coil, whilst the pressure on the vessels causes venous congestion and such obstruction to the arterial supply of the gut as almost certainly to end in its death. The distension of the coil with gas from decomposition of the retained fæces also aggravates the condition.

Symptoms.—Volvulus is rare before the age of forty, and apparently occurs more often in the male sex. A history of chronic constipation will have preceded it, but the acute symptoms start abruptly. Pain is always present, at first intermittent, but finally constant, and there is usually early tenderness over the sigmoid flexure. The pain, vomiting and collapse are not so severe or marked as in other forms of strangulation, but abdominal distension from excessive flatus, and resulting dyspnœa and thoracic embarrassment, are very distressing. Tenesmus is occasionally present. A localized peritonitis is usually developed, but it sometimes becomes diffuse. Natural cure is unknown, the patient either dying in five or six days from collapse and interference with respiration, or at a somewhat later date from peritonitis.

3. **Impacted Foreign Bodies**, causing intestinal obstruction, may be of three types: gallstones, foreign bodies that have been swallowed, or intestinal concretions (enteroliths).

Gallstones can only cause obstruction when of large size, and such usually gain entrance to the intestine by ulceration from the gall-bladder into the duodenum. A coating of fæcal material is likely to form around them, and thus they increase in size as they pass downwards, whilst the intestine gradually diminishes in calibre from the duodenum to the ileum; the usual site of impaction is in the lower ileum. Women over fifty are most often the subjects of this condition, and there may be only a history of some inflammatory condition in the region of the gall-bladder, and none of biliary colic. Such patients frequently suffer from intermittent subacute attacks of incomplete obstruction, which, though severe for a time, are relieved by purgatives. If the gallstone is not passed, a final acute attack supervenes, which begins suddenly with the typical signs of acute obstruction, although the pain and collapse are not so marked as in cases of strangulation, death resulting from peritonitis or exhaustion.

When the obstruction is due to *foreign bodies* which have been *swallowed*, the symptoms are usually subacute to start with, but may lead to perforation if of irregular shape.

Enteroliths are of three classes: (*a*) Calculi of phosphate of lime or inspissated fæces form around some foreign body as a nucleus. (*b*) Masses of indigestible vegetable material may be matted together with inspissated fæces, mucus, etc.; they are said to be not uncommon in Scotland, being mixed up with the husks of the coarse oatmeal there eaten. They have also been shown to consist of hair, or of cocoanut fibre in a patient engaged in mat-making. (*c*) Calculi have been found consisting of insoluble mineral salts, *e.g.*, carbonate of magnesia or chalk, taken as medicine. Whatever their origin, such enteroliths are usually impacted near the cæcum, and if causing acute obstruction the symptoms are similar to those produced by a large gallstone, being preceded probably by chronic attacks and severe colicky pain. In thin persons their presence may be detected by palpation of the abdomen.

4. Acute obstruction ensues when a coil of intestine lodges across a tightly drawn adhesion, the lumen at each end being thereby entirely occluded, and the circulation arrested. The usual acute symptoms follow, which may, however, be relieved spontaneously. Sudden kinking of the gut may lead to the same result, being due to the contraction of fibrous adhesions or the dragging of diverticula.

5. For **Acute Intussusception**, see p. 953.

6. When acute symptoms are developed at the termination of a case of chronic obstruction, the pain from being intermittent becomes constant, the vomiting more violent and fæcal in character, and the fatal termination is due to acute peritonitis or to exhaustion and toxæmia. Absolute constipation is always present, and the abdomen is much distended.

The **Diagnosis** of acute obstruction is not *per se* a matter of much difficulty, since the phenomena are extremely characteristic; but it is usually impossible to make certain of the cause of the obstruction apart from an exploratory laparotomy.

Some care is also needed in distinguishing true obstruction from the obstructive symptoms associated with acute localized enteritis or peritonitis, such as is seen in appendicitis, when the intestinal walls are paralyzed. This pseudo-obstruction is sometimes very marked, and even fæcal vomiting may occur, but by a careful attention to the history and general condition of the patient a correct diagnosis should be reached. We append a table illustrating the chief diagnostic points between acute strangulation and acute appendicitis associated with peritonitis, one of the commonest causes of pseudo-obstruction:

	ACUTE INTERNAL STRANGULATION.	ACUTE APPENDICITIS WITH PERITONITIS.
Onset - -	Abrupt.	May be preceded by local pain.
Rigor - -	Absent.	Often present.
Temperature	Subnormal at first, rising at onset of peritonitis.	High at first, falling later from exhaustion or toxæmia.
Pain - -	Severe; referred to the umbilicus.	Severe; mainly referred to the right iliac fossa.
Tenderness -	Absent till peritonitis comes on.	Present over cæcum even in early stages, and gradually spreading.
Vomiting -	Early, marked, and soon fæcal.	Less urgent, and seldom fæcal, except as a late symptom.
Abdominal parietes -	Flaccid till peritonitis is present.	Tense and rigid from the first.

The **Treatment** of acute obstruction is practically included in one word—**Laparotomy**. The condition of the gut is in most cases identical with that found in a strangulated hernia, and although a few patients may recover by palliative measures, *e.g.*, enemata, opium, ice, etc., yet the majority would be actually injured by the delay caused by their use. The danger of laparotomy increases directly with delay; hence, the sooner it is undertaken, the better for the patient. Whilst preparations for the operation are being made, an enema may be administered to clear the lower bowel, ice being given to suck, and a small dose of opium to relieve urgent pain. Two main objects must always be kept in mind in the operative treatment of such cases, viz., (*a*) to empty the distended bowel, and (*b*) to remove the cause of the obstruction. The second of these requisites is always most desirable, but unless at the same time the putrid contents of the upper portion of the intestine are evacuated, but little real good has been accomplished, since the patient is being slowly poisoned by septic absorption. The late Mr. Greig Smith has declared most emphatically that 'no operation for intestinal obstruction is complete if the patient leaves the operating-table with a greatly distended abdomen.' Moreover, it must be remembered that the formation of an artificial anus is often insufficient to give relief, owing to the paralyzed and distended condition of the intestinal wall above. Hence, in many cases, it is desirable to deal with the engorged bowel first, and to leave the search for the obstructing body till a later date. A very high death-rate must always be expected in these cases, but statistics go to prove that primary enterotomy and evacuation of the intestinal contents, without necessarily dealing with the source of the obstruction, give results in many instances equal to, or even better than, treatment directed towards the cause of the trouble.

In the *most urgent cases*, where the patient's abdomen is acutely distended, and fæcal vomiting has been present for some time, it is not advisable to administer a general anæsthetic; if such is attempted, the patient's life is often lost from stoppage of the respiration, precipitated possibly by a severe attack of fæcal vomiting. A few drops of cocaine may be placed under the skin, and a small incision made through the linea alba below the umbilicus; the first presenting coil of intestine is withdrawn, and stitched to the skin by a few points of suture. A small opening is then made so as to allow a Paul's tube to be introduced and tied in, and whilst the bowel is emptying itself more stitches are inserted. Failing this, a large trocar and cannula may be introduced, and thus the first gush of flatus and fæces carried away from the wound. The stomach should always be thoroughly washed out with warm water before or during the operation.

In *less severe cases*, the stomach should be washed out as a preliminary measure before administering the anæsthetic. The abdomen is then opened in the middle line below the umbilicus, and a definite search made for the cause of the obstruction. The hand is first passed to the hernial regions, and then to the right iliac fossa, so that the cæcum may be examined. If this is distended, the cause necessarily lies below it; if collapsed, above it. In the former case, the condition of the sigmoid flexure should next be investigated, and finally, if this viscus is collapsed, the hand should be run along the colon. If the cæcum is collapsed, perhaps the best method to adopt is to gently withdraw from the abdomen successive portions of gut, about a foot at a time. These are carefully examined, and replaced by the assistant whilst the next portion is being withdrawn. The remainder of the intestines during this process are protected and kept back by the application of towels which have been dipped in warm carbolic lotion (1 in 60). The obstruction is in this way sooner or later discovered, and may be dealt with according to circumstances. If the intestines are too distended to allow of such manipulation, it may be advisable to open or tap one or more of the dilated coils, and thus reduce the distension before proceeding with any methodical search for the obstruction.

Omental bands or peritoneal adhesions should be divided between ligatures. The vermiform appendix or Meckel's diverticulum may be excised, and entirely removed according to the method described at p. 889. A volvulus should be untwisted, if possible; but this is usually impracticable, owing to peritoneal adhesions, and in such cases it is advisable to withdraw the coil from the abdomen, and, if in the large intestine, to establish an artificial anus. Foreign bodies should be, if possible, displaced forwards or backwards to a more healthy portion of the bowel, and then removed by a longitudinal incision along the anti-mesenteric border, the wound being subsequently closed by a row of Lembert's sutures. Of course, volvulus of the small intestine or gangrene of the gut, if present, may necessitate an enterectomy.

Chronic Intestinal Obstruction.

The **Causes** of chronic obstruction are very numerous, and, looked at from an anatomical standpoint, may be divided into the following groups:

1. Intra-intestinal conditions, *e.g.*, impaction of fæces, foreign bodies, etc.
2. Affections of the intestinal walls, such as stricture, new growths, adhesions or matting together of coils of intestine, contraction or kinking of the gut from mesenteric gland disease, etc.
3. Compression of the bowel by tumours, cicatricial bands, etc., developing outside the intestine.

The **General Symptoms** of chronic obstruction are more or less as follows: The patient suffers from gradually increasing constipation, alternating occasionally with watery diarrhœa, spurious in nature, and set up by a catarrhal enteritis due to the irritation of retained fæces. At irregular intervals more severe symptoms arise, consisting of pain, colic, vomiting, and absolute constipation, owing to some temporary complete obstruction, as by a mass of undigested food or fæces becoming impacted, assisted perhaps by a valve-like fold of mucous membrane across the passage. These attacks usually pass off after a time, a copious evacuation of the bowels taking place either naturally or as the result of the administration of a purgative. One of such seizures persists and finally destroys the patient, either by exhaustion, or perforation followed by peritonitis, unless suitable treatment is promptly adopted. The vomiting is never such a marked feature as in acute obstruction, only occurring in the early stages during the subacute attacks; but in the final acute stage it becomes fæcal. The abdomen is always more or less distended and tympanic, and its contour varies with the site of the obstruction; if this is situated above the ileo-cæcal valve, the swelling is mainly central, whilst if in the rectum or lower portion of the colon, it is most marked in the flanks. Distended coils of intestine can be plainly seen through the abdominal walls in thin subjects, as also evident peristalsis. When arising from simple stricture, no tumour is to be felt; but if due to malignant disease, and if the abdomen is not very distended, the growth may possibly be detected.

Fæcal Impaction occurs in adult females who have previously suffered from chronic constipation. The cæcum and sigmoid flexure are the most common seats of obstruction, and a doughy tumour may often be felt at one of these spots, which can in some cases be indented with the fingers, whilst in others it may be of stony hardness. The surface of the mass is usually more or less nodulated, and the intestine tender from the accompanying inflammation. The acute symptoms are always preceded by a prolonged period of malaise and ill-health, the appetite being defective, the breath offensive, and the tongue foul. On rectal examination the presence of scybala may often be felt.

The special symptoms arising from the other conditions which give rise to chronic obstruction, such as stenosis of the bowel, have been already referred to (Chapter XXX.).

The **Diagnosis** of chronic obstruction is obvious, but to ascertain the exact cause of the trouble is often a matter of the greatest difficulty. A thorough investigation of the case, according to the plan given hereafter, must be undertaken, and by this means some conclusion may be arrived at as to the nature and seat of the obstruction.

The **Treatment** of chronic obstruction is always a matter of difficulty and anxiety, owing to the uncertainty often felt as to the diagnosis. It ought to be possible, however, to ascertain whether the block is located in the large or small intestine, since the character of the abdominal distension and the symptoms are tolerably distinctive in the two forms.

If the case is not of the most urgent type, the patient is put to bed, the diet restricted to fluids, and belladonna, combined with small doses of calomel, administered. At the same time copious enemata should be given two or three times daily, but purgatives are studiously avoided, as also opium; probably the patient has taken plenty of the former before coming under observation, whilst the latter, although it may check vomiting and relieve pain, is certain to mask symptoms, and thus prevent the true course of the disease from being wached. Should the symptoms be urgent from the commencement, or the treatment fail, the question of operation has to be faced. If the obstruction is located in the small intestine, a laparotomy must be undertaken, using the same precautions as in acute cases. If the cause of the trouble is easily found, a coil situated just above is withdrawn from the abdomen, opened, and a Paul's tube subsequently tied in so as to allow retained fæcal material to escape. It is wiser not to deal with the local trouble (unless strangulation is present) until the urgent symptoms have disappeared. If, however, the patient's condition is serious and the site of obstruction cannot readily be found, any distended coil may be withdrawn and opened. The practice of allowing numerous coils of intestine to escape in order to facilitate the exploration of the abdomen is not to be recommended.

When the cause of the obstruction is located in the large intestine, colotomy is usually required. The lumbar operation may possibly be undertaken; but the majority of surgeons at the present time prefer the iliac proceeding, although the peritoneum has to be opened, and the risk of fæcal contamination is thus increased. If the rectum or sigmoid flexure is clearly the seat of the trouble, the usual incision on the left side can be made; but if there is no indication as to the part of the colon involved, a median laparotomy is perhaps preferable, a distended portion of the gut being withdrawn, and a Paul's tube tied in.

In chronic peritonitis, where the intestines are hopelessly matted together, but little can be done beyond the administration of enemata, and possibly abdominal massage. The history of the case should generally suffice to suggest its nature, and operative treatment should then be avoided.

Fæcal impaction requires the regular and repeated administration of large enemata, given through a long tube, whilst belladonna and calomel may also be administered. Should hard scybala be lodged in the rectum, it may be necessary to break them up *in situ*, and remove them piecemeal.

Intussusception.

By **Intussusception** is meant the protrusion or invagination of one part of the intestine into another, giving rise to the condition illustrated in Fig. 322. The constituent parts are seen more diagrammatically in Fig. 323. The upper portion is always prolapsed into the lower, except occasionally during the irregular peristalsis which takes place during the death-throes. The invaginated portion (*a*) is known as the *intussusceptum*, whilst the lower portion (*b*) into which it is protruded is known as the *intussuscipiens*. An intussusception, then, consists of three layers—the outer or *ensheathing* layer (i.), an inner or *entering* layer (iii.), and between the two the *returning* layer (ii.). Not only does the intestine enter, but with it a certain portion of the mesentery; and it is to the constriction of the vessels contained therein, and later on possibly to their complete obstruction, that the more urgent symptoms are due, *e.g.*, gangrene, perforation, or rupture of the gut. In addition to this, actual obstruction to the passage of the intestinal contents may be brought about by the traction of the mesentery, which renders the orifice of the intussusceptum slit-like, by the swelling and congestion of the intestinal wall, or possibly by the impaction of a portion of undigested food within the lumen of the gut. Peritonitis usually follows, being possibly due to the invasion of a portion of the damaged intestinal wall by the *Bac. coli*. If limited in extent, it may merely lead to irreducibility of the intussusception, owing to adhesions forming between the serous coats of the entering and returning layers. In other cases, and especially where ulceration or gangrene is present, a diffuse peritonitis may be lighted up, and this may result in the death of the patient. The bowel above the site of invagination becomes dilated, and possibly stercoral ulcers may be formed, particularly in the more chronic cases.

The **Cause** of intussusception may be generally stated to be irregular and violent peristalsis, however induced, whether by the presence of irritating ingesta, or by the existence of polypoid tumours, or possibly worms; the presence of scybalous masses of fæces may also lead to its occurrence. In a few cases injury, *e.g.*, blows on the abdomen, or severe strains during jumping, have been held responsible for its onset.

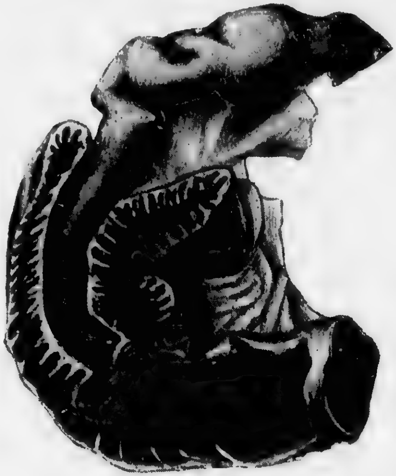

FIG. 322.—INTUSSUSCEPTION. (FROM SPECIMEN IN COLLEGE OF SURGEONS' MUSEUM.)

Intussusception is met with in four chief **situations**: (1) The *ileo-cæcal* variety is much the commonest, constituting 44 per cent. of all cases (Treves). In it the ileum is protruded into the colon, the apex of the intussusceptum being formed by the ileo-cæcal valve. Owing to the great mobility of the ileum, a considerable portion of gut may be thus invaginated, and a good many cases have been observed in which it has actually projected through the anus. (2) The *enteric* variety involving the small intestine is the next most common, being met with in 30 per cent. of the cases. It is most often seen in the lower jejunum, and is rarely of great size. (3) The *colic* form may occur at any part of the colon or rectum, and, owing to the fixity of this portion of the gut, is limited in extent. It is met with in about 18 per cent. of the cases. (4) The *ileo-colic* only occurs in 8 per cent.; in it the ileum is protruded through the ileo-cæcal valve, which for a time retains its normal position; but after the intussusception has attained a certain size, the valve and cæcum are also invaginated into the ascending colon. In each of these varieties except the last the intussusception grows at the expense of the external or ensheathing layer, the apex of the protrusion being always formed by the same portion of gut; but in the ileo-colic variety, as just stated, it increases by the passage of more and more of the ileum through the valve; after a time this stops, and is replaced by the ordinary form of growth.

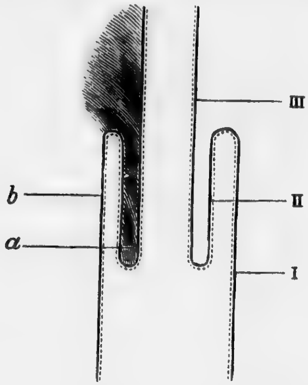

FIG. 323.—DIAGRAM OF INTUSSUSCEPTION

a, Intussusceptum; *b*, intussuscipiens; I., ensheathing layer; II., returning layer; III., entering layer.

Intussusception is occasionally met with as a post-mortem phenomenon, due to the irregular intestinal movements occurring during the death crisis. The condition is recognised as being of this nature by the absence of inflammatory signs, by the fact that it is evidently sometimes due to a reverse peristalsis, and by more than one intussusception being present.

The **Clinical History** varies according to whether the condition is acute or chronic.

Acute Intussusception occurs most frequently in young children, the onset being usually sudden. The child is attacked with severe pain, possibly localized and more or less paroxysmal at first, but rapidly becoming continuous and diffused over the abdomen. This is followed by vomiting, which, however, is less severe than in acute strangulation, and not so often fæculent. The patient rarely suffers from absolute constipation, diarrhœa and the discharge of blood-stained mucus, perhaps associated with tenesmus, being common. Collapse soon supervenes, and in the worst cases this may be so severe as to kill the patient within twenty-four hours; otherwise a fatal issue from exhaustion or peritonitis is reached within a week. On examining the abdomen, but little distension or tenderness is noted, unless acute peritonitis is present; in about half the cases a distinct tumour can be felt, cylindrical in outline, and sometimes described as 'sausage-shaped,' following the course of the intussusception, and generally curved, owing to the traction of the mesentery. In the ileo-cæcal variety it extends from the right iliac fossa across the brim of the pelvis to the left, the colon being dragged downwards. This may be associated with an absence of resistance in the right fossa, which feels empty, constituting what is known as the 'signe de Dance.' In other cases the tumour may be more limited, and distinctly moveable.

A natural cure occasionally follows, resulting either from spontaneous reduction, or from sloughing of the intussusceptum, whilst the peritoneal cavity is shut off by a circle of plastic lymph uniting the ensheathing and entering layers of the gut. When the latter occurs, the subsequent condition is not very satisfactory, owing to the formation of a fibrous stricture.

Chronic Intussusception occurs more frequently in adults than in children, the onset being gradual and the course varying widely in different cases. The patient complains of intermittent attacks of pain of a colicky nature, which recur at intervals, the attacks becoming more frequent and prolonged as the case progresses. Vomiting is often but little marked during the intermissions. The bowels are irregular in their action, and there is sometimes a blood-stained mucous discharge. The general condition is not at first much affected, but as the case progresses emaciation and general asthenia may supervene. On examination, the abdomen is found to be flaccid and free from tenderness, although visible coils of intestine may be observed in some cases, and perhaps a tumour felt. The symptoms are rather those of subacute enteritis and chronic obstruction than of strangulation, and the case may be brought to a fatal termination either by an acute attack of obstruction or by peritonitis. It may, however, last a long time before being recognised.

Treatment.—In the most acute forms of the disease but little can be done, owing to the extreme prostration of the patient; but in the less severe and in the chronic cases much can be attempted to prevent a fatal issue.

In acute intussusception the patient should be at once placed under the influence of opium, in order to still peristalsis and prevent the increase of the tumour. Possibly a cure may be in this way induced; but if the symptoms persist, inflation of the bowel with air, or the injection of copious enemata of warm water or oil, may be carefully undertaken. No undue force should be employed in this proceeding, and a hand placed over the tumour may enable the surgeon to detect whether or not it has been successful. It is performed by raising the patient's pelvis and inserting into the rectum a catheter, with which is connected an indiarubber tube and funnel, held about 1½ or 2 feet above the patient's abdomen. Should this not succeed, laparotomy should be performed without delay, and the condition of the intussusception investigated. An attempt is then made to reduce it by grasping the tumour in one hand and gently trying to peel off the ensheathing layer from the upper portion of bowel, which is steadied by the other hand. In about half the cases reduction is impracticable, owing to the presence of adhesions, and if the general condition of the patient is fairly good, the intussusception should be removed and the divided ends of the bowel united by suture. This is best performed by a modification of Maunsell's method, an incision being made through the anti-mesenteric border of the intussuscipiens, through which the intussusceptum is drawn out and cut away, and the bowel subsequently sutured as described at p. 869. If, however, the patient is in a condition of profound shock, all that can be done is to fix the bowel in the wound, and make an artificial anus. The results of these procedures are anything but encouraging, for F. H. Wiggin* has shown that few children recover if anything more than simple reduction is required during a laparotomy.

Chronic intussusception is more favourable in its prognosis. It is frequently unrecognised until an exploration of the abdomen is made, and hence reduction by inflation is not commonly attempted. In some cases the tumour may be reduced by simple manipulation, but as a rule too many adhesions are present. Excision of the mass should then be undertaken, and the results gained have been very encouraging.

Investigation of a Case of Intestinal Obstruction.

As already indicated, the cause of intestinal obstruction is by no means always a matter of easy diagnosis, whilst the localization of the lesion with a view to accurate operative treatment is never simple. In every case the surgeon should conduct his examination in a methodical and orderly manner, and it is well to make one's investigation on the following lines:

1. The **Previous History** of the case should be carefully gone

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* *Medical Record*, January 18, 1896.

into, in order to ascertain whether or not the patient has suffered from biliary colic, chronic constipation, acute diffuse or localized peritonitis, uterine derangements, syphilis or dysentery, etc.

2. The **History of the Present Attack** should then be considered, noting especially the manner of onset, whether acute or gradual, the duration of the symptoms, and whether or not preceding subacute attacks have occurred from time to time. By this means it is possible to ascertain whether the patient is suffering from acute or chronic obstruction, as also whether the causative lesion has been in existence for some time or not.

3. The more prominent **Symptoms** must then be considered.

(*a*) *Collapse* results partly from reflex nervous disturbance, partly from the absorption of toxic materials. The former cause is most active in the early stage of acute obstruction, especially in infants, whilst the latter is largely responsible for the exhaustion seen at the end of an acute attack or in the chronic variety. Hence collapse is early in acute cases, late in chronic. Moreover, the higher the lesion, the greater the shock, owing to the fact that the upper portion of the bowel is more intimately associated with the sympathetic nervous centres.

(*b*) *Pain* is a very marked symptom, being usually referred primarily to a little above the umbilicus, and is more severe in lesions of the small intestine than in the colon. It varies greatly with the completeness or not of the obstruction. This matter has been especially emphasized by Treves, who has pointed out that when the obstruction is but partial the pain is intermittent, whilst when the block is complete the pain becomes continuous. Hence in acute strangulation pain is almost invariably constant, whereas in stricture it is markedly intermittent. The amount of pain, moreover, varies with the nervous excitability of the patient; it is increased by anything which induces peristalsis, *e.g.*, food or purgatives, and it is diminished on the supervention of gangrene.

(*c*) *Abdominal tenderness* is rarely observed in the early stages, being caused by the onset of inflammation of the peritoneum.

(*d*) *Vomiting* is an almost invariable accompaniment of obstruction. Its cause is still a matter of some doubt, since some authorities claim that it is due to a reverse peristalsis, whilst others maintain that the ordinary onward movements of the bowel are quite sufficient to explain it; the intestinal contents are urged forwards against the face of the obstruction, and, being unable to pass, an axial regurgitant stream is produced. It is a little difficult to see how this could occur when the lower end of the colon is the part affected. Whatever the mechanical explanation, there is no question as to the influence of the nervous system in its production, or as to its being chiefly reflex in character, as is evident from the fact that it occurs equally when omentum or bowel is strangled. Hence, it is easy to understand that it commences early in children and sensitive women, on account of the greater irritability of their nervous centres, whilst it is also more marked when the small intestine is involved. Anything that tends to increase peristalsis naturally intensifies its occurrence. When the obstruction is situated in the jejunum or upper part of the ileum, the vomiting is never really fæcal in character, although, if it has been temporarily checked by opium, it may be exceedingly offensive and dark in colour, owing to decomposition; true fæcal vomiting can only come from an obstruction to the lower ileum or colon.

(*e*) *Constipation*, although usually present, is not necessarily absolute, as it is not impossible for the lower bowel to be emptied in cases of obstruction, whilst the patient not unfrequently passes a motion as gangrene supervenes or death is approaching.

4. A most careful **Physical Examination** must now be instituted.

(*a*) *An inspection* of the uncovered abdomen should first be made. The amount and character of the distension is observed, and whether or not it is situated in the centre, as when small intestine is involved, or in the flanks when the obstruction is in the rectum or sigmoid flexure. The existence of visible peristalsis or enlarged coils of intestine should be noted; such are rarely seen in the acute cases, but may be very evident in the chronic forms. The rise and fall of the abdomen during respiration should be watched to ascertain whether the movements are equal on both sides, or if any prominence, such as would be caused by a tumour, is noticeable. The general condition of the patient, whether emaciated or not, as also the appearance of the face and the position in which he lies, should be observed.

(*b*) All the normal and abnormal hernial apertures should be carefully investigated, as also the rectum and vagina.

(*c*) The abdomen is carefully palpated, so as to ascertain the existence of any tumour, or increased resistance of the abdominal walls.

(*d*) *Percussion* may also throw some light on the case.

CHAPTER XXXIII.

RECTUM AND ANUS.

Congenital Malformations.

The lower portion of the intestinal canal, 8 inches in length, which is commonly known as the rectum, arises from the union of two separate divisions—one, by far the larger, developed from the lowest portion of the primitive hind-gut, and the other an involution from without. The former of these is originally in communication with the bladder, and forms a joint cavity or cloaca; the two are, however, early separated, and the posterior segment, which becomes the rectum, extends down into the pelvis, to be joined by an epiblastic pit or involution growing in from the perineum, known as the 'proctodeum.' Failures in typical development may be due either to the proctodeum being absent or stenosed, to the rectum either being absent or retaining in measure its cloacal condition and opening into some other viscus —*e.g.*, bladder, urethra, vagina, or vulva (Fig. 324, B)—or to want of union between the upper and lower segments. The following are the chief clinical varieties of malformation met with:

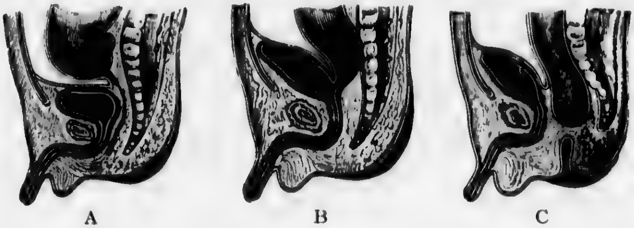

Fig. 324.—Three Varieties of Malformation of Rectum. (Tillmanns.)

In A, the bowel ends at the brim of the pelvis in a cul-de-sac, and there is no evidence of an anus; in B, the anus is also absent, but the bowel opens into the bladder; in C, the anus and bowel are only separated by a small space.

(i.) Absence of the anus, with or without development of the rectum, which, if present, may open in some abnormal situation. In such cases, the important question to be settled by the practitioner is the existence or not of a rectum, and this, unfortunately, cannot always be determined without an open exploration through the perineum; if, however, during crying and straining there is a distinct bulge in the middle line at the spot where the anus should be, there is every likelihood of the viscus being present. If so, it is always expanded in a club-like extremity, usually lined with peritoneum in front, and often below. If the rectum is absent, it usually ends near the pelvic brim, and is merely represented by a fibrous cord below that level (Fig. 324, A).

(ii.) A membranous septum may persist between the upper and lower segments, placed about an inch from the anus, and allowing the retained meconium to push it downwards. This is the type of malformation most commonly met with (Fig. 324, C).

(iii.) An anus is occasionally present, whilst the rectum ends blindly above the pelvic brim, or opens elsewhere.

(iv.) The anus, though present, may be contracted.

The **Treatment** of these cases must be instituted at as early a date after birth as possible, so as to prevent intestinal obstruction.

Anal stenosis is readily dealt with by regular dilatation with bougies.

Where a membranous septum persists between the proctodeum and rectum, a large trocar and cannula may be passed through it, and the meconium allowed to escape; the aperture thus made is enlarged, and maintained by the subsequent passage of bougies.

Where the anus is absent, whether there is any indication of the presence of a rectum or not, a *perineal incision* is first made through the site of the anus, and carried upwards and backwards along the concavity of the sacrum strictly in the middle line for not more than 2 inches, though it is justifiable to proceed further by removing the coccyx and part of the sacrum (Kraske's operation, p. 971). If found, the dilated and bulbous cul-de-sac is drawn down as far as possible, and opened towards its posterior aspect; the mucous membrane is then, if feasible, stitched all round to the skin so as to leave no surface to granulate, thereby preventing subsequent stenosis. In cases where no rectum is present, *colotomy* must be performed, and by preference the iliac operation, since the space between the crest of the ilium and the last rib is exceedingly small in an infant. When once a passage for the fæces is established, abnormal openings into the bladder, etc., usually close without difficulty.

Various malformations in connection with the post-anal gut have been already described (p. 815), and need not be again referred to.

Inflammation of the Rectum (*Proctitis*) causes pain of a bearing-down character, a sensation of fulness, constantly recurring tenesmus, accompanied by a discharge of mucus, muco-pus, or blood. It may arise from any local source of irritation, *e.g.*, the introduction of foreign bodies, or the presence of polypus, parasites, or piles; gonorrhœa is an occasional cause—in women possibly owing to infection from the vaginal discharge, in men probably from direct infection. In dysentery the rectum may be involved as well as the colon. If the inflammation becomes chronic, a simple fibrous stricture may result.

Treatment.—Injections of lead and opium or of borax may be used locally, whilst the patient is kept in a recumbent position and on a low diet, the bowels being regularly opened by the administration of laxatives or enemata.

Thread-worms (*Oxyuris vermicularis*) are the most constant source of irritation of the rectum in infants and children. They give rise to pruritus ani, a discharge of muco-pus, and many reflex phenomena. In treating such a case, a sharp purgative may be given every morning (*e.g.*, pulv. scamm. co., grs. v.), and salt and water or an infusion of quassia used as an injection.

The **Bilharzia hæmatobia** is occasionally found in the rectum as well as in the urinary passages. It gives rise to fibro-adenomatous polypi, in which the ova can be readily demonstrated; they are rounded or oval bodies, differing from those found in the urine in that they possess a lateral spine-like projection, whilst in the latter it is terminal. Considerable tenesmus, diarrhœa and discharge of blood are present, and the latter may become so abundant as to destroy the patient's life, especially when urinary symptoms are coexistent. They occur in children who have been in Africa, and unfortunately no satisfactory treatment is known.

Ischio-Rectal Abscess.

Suppuration in the ischio-rectal fossa (*localized periproctitis*) is very frequently met with, and, from the fact that it commonly results in a fistula, is of considerable surgical interest. It may arise from a variety of causes, but for convenience may be described under the three following headings:

1. **Acute Ischio-Rectal Abscess** is due to infection of the loose fatty tissue filling the ischio-rectal fossa with some pyogenic organism, reaching it either through the perineum or from the bowel. In the latter case some solution in the continuity of the mucous membrane occurs, such as may follow its penetration by a fish-bone or other foreign body, or some form of ulceration; the *Bac. coli* is thereby set free, and in consequence the pus has the usual characteristic offensive odour. If the infection is derived from the perineum, the usual cocci of suppuration are present, and the pus has no objectionable smell. A red, painful swelling is noticed on one side of the anus, which is at first hard

and brawny, but soon becomes soft and fluctuating. Defæcation is exceedingly painful, as also digital exploration of the bowel; and the patient is unable to sit with any comfort. If left to itself, it may burst internally or externally, or in both directions, and a fistula-in-ano is very liable to follow. **Treatment.**—In the early stages the part should be well fomented with hot water, but when there is no doubt that pus is forming, a free opening should be made, the cavity washed out, and stuffed with some antiseptic dressing. If taken early enough, rapid recovery may ensue without the bowel becoming involved, but when the mucous membrane has been encroached upon or perforated, the wound will not heal without division of the sphincter.

2. **Chronic Ischio-Rectal Abscess** is usually met with in run-down or tubercular individuals during young adult life, and is not unfrequently a complication of phthisis. It arises from injuries to the perineum or bowel, and may even be induced by exposure to wet or cold, as by sitting on a damp stone. A deposit of tubercular material replaces the fat ordinarily occupying the ischio-rectal fossa, and this after a time undergoes caseation or breaks down into an abscess, which gradually spreads without pain or other inflammatory disturbance, until it may extend very widely, and almost entirely surround the bowel. After it has burst, the orifices of sinuses may be found at a considerable distance from the anus. The **Signs** and **Symptoms** are those of a chronic tubercular abscess. An indurated and painless mass may be first felt in the fossa, and this slowly spreads, softens, and is transformed into a more or less extensive abscess sac. The **Treatment** is as for all tubercular deposits, viz., in the early stages, and even before suppuration has occurred, incision, removal by sharp spoon of all tubercular tissue, the application of pure carbolic acid, and dressing the wound with gauze infiltrated with iodoform. Where extensive sinuses or fistulæ exist, treatment as for fistula-in-ano must be adopted.

3. Suppuration in the ischio-rectal fossa may occasionally be dependent on disease of neighbouring or distant structures, *e.g.*, the sacro-iliac or hip joints, the spine, prostate, pelvic cellular tissue, etc., the pus finding its way down by the side of the rectum to reach the surface. The usual treatment of such conditions must be adopted, but if practicable the abscess should be opened elsewhere, as, of course, the existence of a sinus near the anus is a fertile source of septic contamination.

Anal Abscess.—This term is applied to an abscess forming immediately under the anal integument, and situated superficial to the sphincter; it is usually due to inflammation of one of the numerous sebaceous follicles in that locality. It may be acute or chronic, in the latter case being usually tubercular, and is one of the most frequent causes of fistula-in-ano. It must be freely opened throughout its whole length, and plugged with gauze dressing.

Fistula-in-Ano.

The term fistula-in-ano is somewhat loosely applied to all those conditions in which suppurating tracks are found in the neighbourhood of the anus and the lower end of the rectum. Many of these are merely sinuses in that they have but one opening.

The **Cause** of fistula is usually some suppurative condition, *e.g.*, an ischio-rectal or anal abscess, in the neighbourhood of the bowel; but it sometimes arises as the result of a stricture of the gut, the inner opening being either above, in the substance of, or below the cicatricial mass. This is more likely to be the case when multiple fistulæ exist.

Varieties.—1. The *Complete Fistula* (Fig. 325) is one in which there are openings both externally and into the bowel. When following an anal abscess, they are both close to the anus, and the track lies immediately beneath the skin and mucous membrane. When following an acute ischio-rectal abscess, the external opening is about $\frac{1}{2}$ inch from the anus, and the inner about 1 inch up the bowel, being situated just above the so-called internal sphincter; occasionally blind extensions are met with branching off from this, but not so frequently as when the fistula follows a chronic abscess. In the latter case the skin may be extensively undermined, looking blue and congested, and the fistulous tracks may burrow widely, opening even on the thigh or in the perineum or buttock. Another variety is that in which it passes round the bowel either superficial to the external sphincter or in its substance, and opens also on the other side, constituting the so-called *horseshoe fistula*. Again, the mucous membrane of the bowel is often undermined, and stripped from the muscular coat for some distance above the internal opening by sinuses or an abscess cavity.

2. The *Blind External Fistula* (Fig. 326) is the term applied to a sinus resulting from the opening of an ischio-rectal abscess in which no communication with the bowel can be discovered. A probe passed into the wound can often be felt by a finger in the rectum with only the thickness of the mucous membrane between. In dealing with these external fistulæ the possibility of the original cause being at a distance must not be overlooked.

3. The *Blind Internal Fistula* (Fig. 327) is constituted by a sinus opening into the bowel just above the anus. Attention is usually drawn to the condition by the passage of pus with the motions or independently, and perhaps by preceding inflammatory disturbance. The orifice can sometimes be felt by digital exploration, and on the insertion of a speculum may perhaps be seen and carefully examined by a straight probe or one bent in the form of a hook; it is often associated with considerable undermining of the mucous membrane.

In all these conditions it is very difficult to obtain healing, owing to the state of unrest in which the parts are kept by the continuous movements, voluntary and involuntary, of the sphincter; hence division of this muscle is almost always necessary. It may, however, be advisable to leave the case alone when the fistula complicates the *later* stages of phthisis, or when a small blind internal fistula exists in elderly people, causing but little inconvenience and no injury to the general health.

Operation.—The bowels must have been completely evacuated, both by means of castor-oil or some suitable purgative, and about an hour previous to operation by enema, a most important preliminary, not only for the comfort of the operator, but also because it is very desirable that no further action should be required for some days. The patient is placed in the lithotomy position, and the perineum and anal regions shaved and purified. A probe is passed along the fistula into the rectum, and guided by it a grooved director, along which a curved pointed bistoury is introduced, and the intervening structures divided; this will in most cases include the external sphincter. A careful search is made for pockets or tributary branches of the main track, and such, if found, are opened up and scraped out, undermined and unhealthy skin being snipped away with scissors; bleeding-points are, if necessary, tied, and the cavity carefully powdered with iodoform, and lightly stuffed with oiled lint or gauze soaked in iodoform and glycerine. Pressure by a graduated antiseptic wool compress should be applied by means of a T-bandage. The wound is allowed to granulate, and care taken that irregular healing does not lead to a re-formation of the fistula. With this object in view, it is often advisable to pass a moderate-sized bougie from time to time at the end of a fortnight.

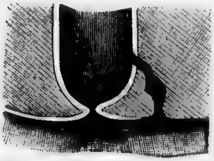

FIG. 325. — COMPLETE FISTULA-IN-ANO WITH EXTERNAL AND INTERNAL OPENINGS. (TILLMANNS.)

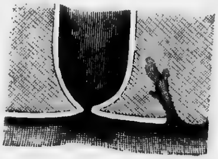

FIG. 326.—INCOMPLETE EXTERNAL FISTULA. (TILLMANNS.)

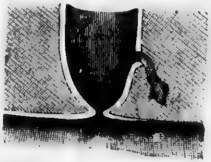

FIG. 327.—INCOMPLETE OR BLIND INTERNAL FISTULA. (TILLMANNS.)

When a sinus extends up for some distance under the mucous membrane from the upper end of the original fistula, it may not be always desirable to lay it open to its whole extent, since such might involve serious hæmorrhage at a spot where it cannot well be checked. It will often suffice to partly divide and scrape it, and then, if the main fistula has been satisfactorily dealt with, it will probably heal without difficulty, especially if syringed out occasionally with stimulating lotions.

In the case of a horseshoe fistula, the sphincter need only be divided at one spot, and that usually on one or other side. The whole track must, however, be opened up, the cavity scraped, loose tags of skin removed by the scissors, and an ordinary dressing applied.

After-treatment.—The bowels should, if possible, be kept quiet for four days, and most scrupulous care taken to keep the parts clean. The deep dressing need not be changed for the first twenty-four or forty-eight hours, provided that the surrounding skin is well flushed with a warm carbolic solution. When the plugs are removed, fresh small strips of gauze soaked in iodoform and glycerine are introduced night and morning after the wound has been syringed. On the fourth day a good dose of castor-oil should be given, and subsequently care taken to secure an action of the bowels daily.

Fissure of the Anus is a most painful and troublesome complaint, met with most commonly in women of a neurotic temperament, or in individuals whose health has been broken down by long residence in the tropics. It is occasionally due to injury or to a polypus, but more often to the passage of large scybalous masses in patients suffering from chronic constipation. The fissure is most commonly single, extending through the posterior border of the anus towards the coccyx; a 'sentinel' external pile is often situated immediately over it, and the crack may lead to a definite ulcer just within the external sphincter. According to Ball of Dublin, it is due to one of the anal valves, left at the site where the proctodeum and rectum meet, being caught by a scybalous mass, and torn from its upper connections. Each time a motion passes, the sore place is reopened, and the valve pushed further on, until finally it appears at the orifice as the 'sentinel' pile, with an ulcerated surface behind or beside it. Sometimes several fissures are met with in the same individual, and then a syphilitic cause is probable, especially if they are placed at the side or front of the anus.

The **Symptoms** of this condition are very distressing, consisting of burning pain during defæcation, which often lasts for some hours. The pain is usually associated with tenesmus, and may radiate down the thighs or up the back, and not uncommonly to the left sacro-iliac joint; it may be so severe as to lead the patient to refrain from defæcation for prolonged periods. The fæces may be streaked with blood or pus, and there is a certain amount of discharge from the anus. On examining the part, the sphincter is found to be spasmodically contracted, and the entrance of a finger is forcibly resisted.

Treatment is, in the earlier stages, undertaken by regulating the action of the bowels by suitable laxatives, by the use of cocaine suppositories prior to defæcation, and by improving the general health. In confirmed cases the sphincter has been forcibly dilated by the thumbs, and the crack or ulcer cauterized; but by far the most efficient treatment consists in dividing its base with a straight probe-pointed bistoury, the incision at the same time including the external sphincter. The ulcer and the edges of the wound are snipped away with scissors, to facilitate the dressing and healing of the wound. The lower bowel should in all cases be carefully explored with the finger, especially with a view to the possible existence of a polypus, which, if undetected, would cause a recurrence of the mischief. Rest being thus obtained, healing soon follows.

Fibrous Stricture of the Rectum.

One of the most important conditions associated with or resulting from inflammatory lesions of the lower gut is stenosis. It is usually met with in advanced life, especially in women over forty years of age, and is most often situated 2 or 3 inches from the anus, or as high as its junction with the sigmoid flexure. In this position, it is usually due to the cicatrization and contraction of ulcers following prolonged diarrhœa and dysentery, although occasionally due to tubercular ulceration. Any form of chronic proctitis, *e.g.*, gonorrhœa, may also lead to it. It occurs sometimes as a sequela of pelvic cellulitis and suppuration, from the contraction of fibrous bands which may bind the rectum backwards to the sacral wall, or may merely constrict it; the stricture is in these cases usually at a lower point than in the former. Repeated attacks of inflamed piles may also lead to stenosis at or just above the anus.

The earliest **Symptoms** of stricture are often alternating attacks of diarrhœa and constipation, in which the constipation is primary, and the diarrhœa due to a catarrhal enteritis arising from the irritation of the retained fæces. Gradually the difficulty in passing motions becomes more and more marked, and the fæces themselves become narrowed, flattened, and elongated, something like pipe-stems, or small masses like shrimps may alone succeed in passing. This is associated with pain and uneasiness referred to the lower bowel; a certain amount of blood and mucus may be mixed with the excreta, and sooner or later marked dyspepsia and abdominal distension supervene. If the case is allowed to run on without treatment, absolute obstruction of a chronic type may result, and lead to a fatal issue; or the mucous membrane of the bowel above the stricture becomes ulcerated, an abscess forms, and subsequently a fistula, through which a certain small amount of fæcal material passes. If several of these fistulæ are established, the patient may finally succumb to chronic septic poisoning and exhaustion. Occasionally, as pointed out by the late Mr. Henry Smith, the internal opening of a fistula is found below, or in the substance of the stricture itself, and in such cases the fistula may have been the primary trouble.

An examination of the bowel with the finger may reveal a smooth, regular constriction of the gut as if a band had been tied round it, the fibrous mass and the aperture in it feeling something like an os uteri. In other cases, the bowel is stenosed for some distance, and its surface more or less ulcerated; whilst if due to pelvic cellulitis, it may be drawn up and fixed to the posterior pelvic wall. When the stricture is too high for the finger to reach, the gut may appear normal, though somewhat dilated (ballooning). Sometimes the stricture is smooth, and free from nodular irregularities and excrescences; often, however, it is ulcerated and irregular, the examination causing great pain. The gut above the contraction is hypertrophied, distended, and filled with retained fæces, with the mucous membrane showing signs of inflammation, or even stercoral ulcers. The gut below the stricture is usually dilated (ballooned), partly from paralysis of its walls, and partly by invagination of the mass from above.

The **Treatment** in the early stages consists in keeping the bowels regular and the motions soft by means of laxatives, such as castor oil or salines, whilst the passage of the excreta is assisted by enemata. The diet is regulated, and the strength maintained, if need be, by tonics. Locally, the stricture, if within reach, should be dilated by means of bougies passed in increasing sizes every two or three days, care being taken that the point of the instrument engages the stricture, and is not caught against folds of mucous membrane or turned backwards. The utmost gentleness must be used, in order, as far as possible, to stretch the mucous membrane, and not tear it. Laminaria or compressed sponge tents are of use in some cases, followed subsequently by bougies. When situated low down, the stricture may be notched posteriorly, or slightly nicked in several places with a probe-pointed bistoury, and bougies then passed. There is always a great tendency in these strictures to contract again, and the patient should be instructed to pass a bougie for himself at short intervals. If the stricture is out of reach, or signs of obstruction manifest themselves in spite of treatment, colotomy is the final resource.

Syphilitic Disease of the Rectum and Anus.

The rectum and anus are attacked by syphilitic disease in a variety of ways, the most prominent being as follows:

(*a*) The initial lesion or primary chancre is occasionally met with in the neighbourhood of the anus, but presents no features especially demanding attention.

(*b*) In the secondary stage mucous tubercles or condylomata are frequently seen, being placed either at the anal margin or symmetrically on either side of the gluteal fold, the sores on one side having evidently infected the other. They present the usual features (p. 1106), and are treated by dusting with powdered calomel, and keeping a piece of dressing between the lips of the fold.

(*c*) In the tertiary period *diffuse syphilitic disease of the rectum* is not uncommon, occurring most usually, but not solely, in young married women amongst the poorer classes, and especially in hospital patients. It is a somewhat early tertiary manifestation, and commences within easy reach of the finger, about 3 inches from the anus. It starts as a diffuse gummatous infiltration of the rectal mucous membrane and submucous tissue, which become thickened and indurated, ulceration soon following. These phenomena are not limited to the rectum, but tend to spread not only up the intestine towards the sigmoid flexure and down to the anus, but also involve the recto-vaginal septum and vagina, passing down the latter canal to invade the perineum and neighbouring structures, so that in a neglected case the whole external genitals and anus may be involved in an irregular hypertrophic mass, somewhat resembling elephantiasis. In addition, the ulcerative process may extend more deeply, leading to the formation of fistulæ, not only between the rectum and neighbouring viscera (*e.g.*, vagina or bladder), but also communicating with the exterior. From the cicatrization occurring in the submucous tissue, contraction of the gut results, causing a *syphilitic stricture*, which may extend for some distance up the bowel. The symptoms consist in pain, increased on defæcation, irritability of the bowel, and discharge of blood and pus by the anus, whilst obstructive phenomena, or alternating attacks of constipation and diarrhœa, may also be present. On examination, the diffuse ulceration and infiltration of the part are suggestive of malignant disease, but the patient's age and history, and the course of the case, are usually sufficient to determine the diagnosis. The general health remains good in the earlier stages of the affection, but later on may be undermined by the pain and constant purulent discharge.

Treatment consists in administering mercury and iodide of potassium, the former perhaps in the shape of suppositories, whilst locally dilatation by bougies is necessary. In advanced cases colotomy is essential in order to secure rest to the parts, and allow them a chance of healing. Possibly in a few instances only a temporary opening of the bowel may be required, but where much contraction exists, and a considerable tendency to obstruction, the artificial opening must remain permanently.

Sometimes the ulceration persists in spite of colotomy, and care must then be taken to prevent the retention of discharges by the occasional passage of bougies.

Tumours of the Rectum.

Polypus Recti occurs most frequently in children, and consists usually of an adenoma of Lieberkuhn's follicles, but occasionally of simple fibrous tissue covered with mucous membrane. They are commonly found within easy reach of the anus, and present an appearance something like a small cherry with a long pedicle, pendulous and freely mobile. The **Symptoms** caused are irritability of the bowel and the passage of blood by the anus, which latter when occurring in a child without symptoms of obstruction is almost pathognomonic of polypus. The tenesmus excited may lead, as mentioned elsewhere, to prolapse or to the occurrence of an intussusception. It is occasionally associated with a fissure of the anus, which probably arises as a secondary result of the irritation, caused by the partial extrusion of the polypus during defæcation. A natural cure can be effected by rupture of the attenuated pedicle, which may lead to a certain amount of hæmorrhage. **Treatment** consists in removal by ligature, torsion, or clamp and cautery, according to circumstances.

Papilloma of the rectum is a rare disease, and gives rise to hæmorrhage from and irritability of the bowel, or, if large, even to obstruction. This condition is not always limited to the rectum, but may extend through the greater portion of the intestine, and then may prove fatal from hæmorrhage. **Treatment** consists in removal by ligature or wire snare, where practicable.

Sarcoma is another rare disease in the rectum. It occurs in the shape of a large fleshy tumour growing from the submucous tissue, and projecting into the lumen of the gut so as to cause obstruction. It is less painful than cancer, and usually occurs at an earlier age. The symptoms are much as in the latter disease. **Treatment**, where feasible, consists in extirpation of the growth, but it will very probably recur.

Epithelioma of the Anus (*i.e.*, of the skin covering the anal margin) occurs as a primary development similar to that on the lip, and is then of the squamous type. It presents the usual features (viz., an indurated nodular mass, which readily ulcerates), and runs the typical course of such a disease, infecting the inguinal glands. It is readily dealt with in the earlier stages by an operation somewhat similar to that for excision of the rectum.

Cancer of the Rectum appears in the form of columnar epithelioma, consisting, as described elsewhere (p. 160, Fig. 42), of an overgrowth of Lieberkuhn's follicles, not only into the lumen of the gut (centrifugal or papillomatous type of growth), but also invading the deeper layers of the bowel wall, infiltrating the submucous and muscular layers (centripetal growth). A certain amount of vascular fibro-cellular stroma is found between the glandular elements, and, according to the relative amount of these structures, two forms of the disease are described: (*a*) The *nodular variety*, commencing at one spot in the form of a localized malignant wart-like mass, which is hard in consistency, and contains an excess of fibrous stroma. This type ulcerates somewhat slowly, and does not grow very rapidly. (*b*) The *annular variety* is characterized by the mass being more cauliflower-like, growing more rapidly, and tending early to involve the whole circumference of the gut. This latter form ulcerates early, bleeds freely, and causes greater destruction of tissue, so that obstruction to the onward passage of fæces is much less likely to occur in it than in the former type, where cicatricial contraction is a marked feature.

Both varieties tend to involve neighbouring structures, and hence lead to fixation of the mass, either to the pelvic walls or to the bladder, vagina, or prostate; or it may compress the iliac vessels or sciatic nerves, causing œdema or neuralgia respectively. Fistulæ may develop in connection with the bladder, in which viscus the growth may actually form a considerable mass. Secondary deposits, similar in microscopic structure to the primary growth, may be found in the lumbar glands, or, if the anus is secondarily affected, in the inguinal region; they very commonly involve the liver, and may even be disseminated throughout the body. The peritoneal cavity may also be invaded.

The **Symptoms** of the disease are often so slight and the onset so insidious as to raise no suspicions of the existence of any growth until it has attained considerable size. It then leads to recurring attacks of constipation, alternating with diarrhœa, and to the discharge of large quantities of mucus, often blood-stained. A sense of weight or dragging pain is noticed in the rectum, and the patient after defæcation feels as if there is still something to be passed. This sensation increases until true tenesmus and straining at stool are present, together with constant pain, which may radiate up the back and down the legs, causing sitting on any hard substance to be painful. At first a blood-stained discharge may be seen on the fæces, which become flattened and pipe-like, but later on it passes independently of the motions. On examination, an ulcerating, crateriform mass is met with, which may either be limited to one segment of the gut wall, and is then usually firm, and perhaps associated with stenosis, or it may surround the bowel, and feel soft and spongy, readily breaking down under the finger, and bleeding freely. This examination is generally painful, as also the process of defæcation, and sometimes the patient abstains from it for lengthened periods on account of the exquisite agony caused thereby. Marked cachexia supervenes, the digestion becomes impaired, any meal causing pain and flatulent distension; natural sleep is impossible, and if a recto-vesical fistula forms, the patient's troubles are further aggravated by the passage of fæces and flatus by the urethra.

The case runs a more or less rapid course to the fatal issue, which on an average ensues about seventeen months after the onset of symptoms, if no operation has been undertaken (Jessop*), and may be due to a variety of causes. Fæcal obstruction occurs in about 30 per cent. of the cases, being more marked in the chronic forms, and in those where the disease starts high up the bowel, on account of the peristalsis causing invagination of the mass and occlusion of the tube; whilst if ulceration is excessive, or the disease situated low down, obstruction is much less common, invagination being here impossible, and peristalsis being expended on the onward passage of the fæces. Exhaustion from hæmorrhage, pain, sleeplessness, or septic absorption, accounts for most of the fatal results, whilst septic peritonitis following the perforation of stercoral ulcers above the growth occurs in a few instances.

The **Treatment** of cancer of the rectum consists in the radical measure of excision of the mass, or in the palliative operation of colotomy.

Excision of the Rectum, or proctectomy, is only applicable to those cases in which there is a reasonable prospect of the whole disease being eliminated. When the finger can be passed into healthy bowel beyond the growth, and where the mass is not fixed anteriorly so as to endanger other viscera, *e.g.*, the prostate or bladder, the case is a favourable one for excision. Fixation of the mass laterally or behind is not so important, although where extensive it also contra-indicates operation. If there is any reason to suspect secondary deposits in the lumbar glands or liver, it is needless to put the patient through the very trying ordeal of excision. Formerly it was considered of vital importance to avoid opening the peritoneum; but at the present day it is frequently done, and with no untoward result, if due precautions are taken; so that, although the growth may be situated high up, if it is freely moveable, and there is no evidence of secondary deposits, an attempt should be made to take it away. It must be remembered that in the male the peritoneum is reached on the anterior aspect of the gut about 2½ inches from the anus, with an undistended bladder, whilst it may be pushed up another inch when that viscus is full; in the female the peritoneum is situated about 4 inches from the anus, being reflected to the posterior aspect of the cervix uteri. Posteriorly, the lower 4 or 5 inches of the bowel are uncovered by serous membrane in both sexes.

Two forms of operation are described, according to whether the growth is situated high up or low down. The latter, or low operation, sometimes known as Langenbeck's, is performed through the perineum; the former, for dealing with cancer situated higher up, necessitates partial removal of the sacrum or coccyx, and is known as Kraske's.

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* *British Medical Journal*, 1889, ii., p. 407.

1. *Low Operation.*—The rectum having been thoroughly washed out and emptied, and the patient placed in the lithotomy position, the posterior wall of the rectum and anus is slit open in the middle line as far as the tip of the coccyx. An incision is now made all round the anus at the junction of the skin and mucous membrane, if the anus is healthy; when diseased, the incision is extended beyond the margin so as to include the growth. The rectum, together with the tumour, is then separated from surrounding structures by scissors and fingers, commencing posteriorly, where this is readily effected, dividing the levator ani on each side, and working gradually upwards and to the front, where greater care must be taken to ensure the vagina, prostate or membranous urethra from harm. In the male, a bougie or catheter may be passed into the urethra with advantage. Bleeding-points can be secured during this process by pressure-forceps. The upper attachments of the gut are divided either by scissors, écraseur, or clamp and cautery. Hæmorrhage, which is generally very free, is arrested by ligature or cautery, and the gaping wound powdered with iodoform, and plugged for twenty-four hours with gauze, the posterior incision not being closed by suture, and no attempt made to drag down the mucous membrane. Subsequently the wound may be left without any internal dressing, an external pad of salicylic wool sufficing; it is thoroughly washed out two or three times a day with some dilute antiseptic, such as sanitas (1 in 10), Condy's solution, or carbolic acid lotion (1 in 60), which may be used alternately; granulations gradually cover the surface, and, as cicatrization progresses, the mucous membrane is by degrees approximated to the skin margin, and the patulous cavity diminished in size until healing is complete.

If the growth affects one side of the gut alone, the operation is modified by only removing that half. If fixed posteriorly, the coccyx, and even a part of the sacrum, may be taken away without hesitation to facilitate the extirpation of the mass.

2. *Kraske's or the High Operation.*—The patient reclining on his right side; an incision is made in the median line from just behind the anus to the middle of the sacrum, but without opening the bowel. The coccyx is excised, and the great sacro-sciatic ligament and gluteus maximus detached from the left side of the sacrum. Part of the left wing of the latter bone is now removed by chisel and hammer, the incision being curved, and extending from the median line below, through or above the fourth posterior sacral foramen to the under border of the third, and then

to the left border of the bone at that level (Fig. 328, *a b*). The loose cellular tissue surrounding the middle of the rectum is thus exposed, and the gut, together with the tumour, is freed from its connections, opened along the median line behind, and amputated from the sound gut above, the peritoneum being usually encroached on in this stage of the proceedings. If the growth extends to the anus, the whole length of the rectum below is excised; but if the sphincter and lower inch or two are free from disease, they are left *in situ*, and not divided posteriorly, whilst the upper end of the gut is in all cases drawn down, and fixed by a few points of suture either to the anal portion along its anterior wall, or to the skin. The wound is carefully washed out, packed with gauze sprinkled with iodoform, and even if the peritoneal sac has been opened, no harm will usually come of it, since a careful packing of the wound will shut it off in twenty-four hours. The results which have followed this severe operation are, on the whole, encouraging.

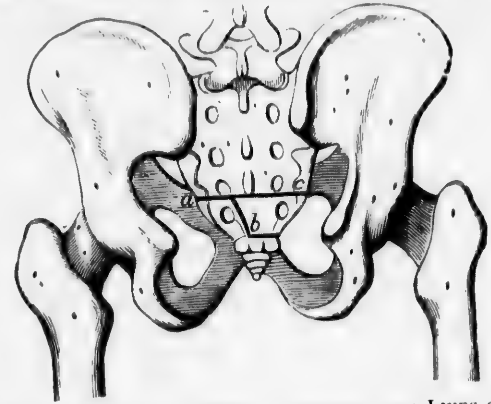


FIG. 328.—PELVIS SEEN FROM BEHIND TO INDICATE THE LINES OF SECTION OF THE SACRUM AND COCCYX IN KRASKE'S OPERATION.

a b, Kraske's original operation; *a c*, Bardenheuer's modification.

Various modifications of Kraske's proceeding have been suggested, one of the best being that performed by Bardenheuer. The sacrum is exposed, sawn across just below the third foramina (Fig. 329, *a c*) and the portion thus detached is totally removed. By this means a much more extensive view is obtained of the pelvic contents, and the scope of operation is increased.

Excision of the rectum is a proceeding only practicable in comparatively few cases of the disease (Jessop states 15 to 20 per cent.), and fatal results are not uncommon from shock, hæmorrhage, or peritonitis. The tendency to recurrence is considerable, but the disease is not then so painful as before, since the nerve terminals have been removed. In the cases that are cured a certain amount of inconvenience is certain to follow either from a patulous or stenosed condition of the anal orifice, and it is still a moot point whether a simple colotomy is not as valuable as excision. Possibly it would be well to do colotomy first, and then attempt excision later.

As already stated, if the radical operation is not feasible, **Colotomy** is the only means whereby the patient's condition can be temporarily ameliorated. The surgeon should not wait until urgent symptoms develop, but should operate at the earliest possible date, and for the following reasons: (*a*) It allows the patient to indulge in solid food, and thus assists in maintaining the general health; (*b*) it frees him from the pain arising from the passage of fæces over the ulcerated surface; (*c*) it retards the growth of the disease by eliminating the irritating action of the fæces; (*d*) it removes all chance of intestinal obstruction from the growth itself; and (*e*) it diminishes the absolute risk of the operation by doing it when the patient is comparatively well and hearty, and when there is no urgency. Formerly the death-rate in these cases was about 30 to 40 per cent.; it has now been reduced to 3 or 4 per cent.

The iliac operation should always be undertaken, for details of which see p. 879.

Should the patient refuse colotomy, or should it be for any reason contra-indicated, treatment consists in limiting the diet to such materials as strong broths, arrowroot, etc., with some stimulant, so as to give as little fæcal remains as possible, and to enable him to do without an action of the bowels for about a week at a time. The strength is husbanded by keeping him in bed, and pain is checked by the administration of morphia.

Hæmorrhoids, or Piles.

By the term **Piles** is meant a varicose condition of the veins surrounding the anus and lower inch or two of the rectum.

The character of the blood-supply of this portion of the bowel, and the conditions under which it is carried on, go far to explain the frequency of this affection. The circulation in the upper half of the rectum is similar to that in the intestine, in that the vessels are distributed transversely around the gut; but in the lower half they run in longitudinal series along the bowel, being connected by transverse branches, which form a plexus around and just above the anus. Their situation in the loose submucous tissue, where there is but little support, necessarily exposes them to great and sudden variations of pressure before and after defæcation. Their dependent position at the lowest part of the portal area, together with the absence of valves, and the fact that they constitute the only communication between the portal and general systems, and thus afford the only means of escape from a block on the portal trunk—all these reasons may be looked on as **Predisposing Causes** of the condition. In addition to these we must also mention a sedentary occupation, alcoholic excess, and chronic constipation, which, by leading to congestion of the liver, are frequent precursors of piles. They are exceedingly common in young people, especially in men about twenty years of age forced to lead a sedentary life; up to middle age the tendency diminishes, but in elderly individuals many conditions arise which tend to produce them. Young women are remarkably exempt from piles, owing probably to the regularity of the menstrual discharge; but uterine conditions, such as pregnancy, displacements, or tumours, which cause obstruction to the venous return, are liable to be associated with them. Many forms of abdominal tumour, *e.g.*, aneurisms, may also determine their existence.

A varicose condition of the veins in the neighbourhood of the anus is often present without being recognised by the individual; but many different circumstances may bring the symptoms into prominence, such as the use of drastic purgatives, especially aloes, local exposure to damp and cold, as by sitting on a cold wet stone or in a draughty closet, or sudden congestion of the liver, as by alcoholic excess, or a chill.

Two chief varieties of piles are described, viz., the external and internal; but frequently a combination of the two conditions is present.

External Piles are found at the margin of the anus, and are covered with skin. They consist of a small central vein in a varicose state, surrounded by a development of subcutaneous fibrocellular tissue, which latter is much more abundant than the vascular element; in fact, they practically consist of longitudinal folds of skin of a dark brown colour radiating from the anus, and superficial to the sphincter. In the usual relaxed state in which they are found they give rise to no **Symptoms** beyond a little pruritus, and perhaps a sense of fulness and irritation immediately before and after defæcation. They are very liable, however, to become *inflamed* from local irritation or cold, and then appear as tense, bluish, rounded swellings, exceedingly painful and tender, and often preventing the patient from walking or sitting in comfort. In such a state the vein contained in the pile is distended with blood-clot. Under suitable treatment the swelling subsides in a few days, usually leaving the fleshy fold more bulky and harder than previously, owing to the partial or complete organization of the thrombus.

The **Treatment** of external piles, when uninflamed, is very simple. Constipation must be relieved; the parts should be kept clean and well washed; a hamamelis ointment or extract may be occasionally applied, and great care taken not to irritate the anus after defæcation by the use of hard paper (*e.g.*, newspaper). Very soft curl-paper, well crumpled, should be employed, or even preferably absorbent wool. It is but rarely that *operative measures* are called for in a simple case of external piles; where, however, external and internal piles coexist, it is advisable to complete any operation undertaken for the latter condition by the removal of the more prominent fleshy-folds surrounding the anus. This is accomplished by grasping them with forceps, and snipping them away by scissors in a direction radiating from the centre of the anus. We would warn the practitioner, however, against a too free use of the scissors, whereby a subsequent contraction of the anus may be induced. For inflamed external piles the patient should be kept in bed, the bowels opened by a copious warm enema, and hot fomentations applied. If the pain and tension are very great, the tumour should be incised and the clot turned out; the margins of the fold may then be cut away, and the wound dressed with iodoform and salicylic wool.

Internal Piles consist of dilated veins held together by a certain amount of connective tissue, and covered by mucous membrane. When cut into, they show an appearance almost like a number of cysts. At first they are quite soft and compressible, and easily emptied on pressure; but when they have existed for some time the connective tissue may be increased in amount, and arterial twigs are often found running into the mass.

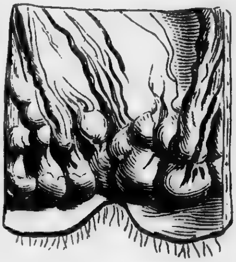


FIG. 329.—INTERNAL PILES.

The condition is limited to the lower 2 inches of the bowel, and may present very varied appearances in different cases. Thus, there may be a general varicosity of the veins in the submucous tissue without the formation of any distinct tumours. The mucous membrane then appears of a deep claret colour, is somewhat thickened, and tends to protrude at every motion. There is a certain amount of mucous glairy discharge, and the fæces may be streaked with blood; but, as a rule, the hæmorrhage is not great. Such a condition is usually followed by a definite formation of hæmorrhoidal tumours, and not unfrequently runs on to prolapse.

When distinct hæmorrhoidal masses form, they may be of two types: (*a*) The *longitudinal* or *fleshy pile* (Fig. 329), consisting of broad sessile masses, dusky in colour, soft and compressible in consistency, and usually covered by mucous membrane, which, although thin and stretched, still remains smooth and shiny, like the skin of a black grape. Between the piles depressions are found, in which small portions of fæces may lodge, and produce irritation. This form usually bleeds but little. (*b*) The *globular* or *bleeding pile* may be single or multiple, and is usually somewhat pedunculated; the surface of the tumour is roughened, and presents a granular, strawberry-like appearance, due to the existence of dilated capillaries. When, however, a portion of it has been repeatedly protruded, the exposed mucous membrane becomes hard, and practically converted into skin. The hæmorrhage is often abundant, and comes either from the dilated superficial capillaries, or occasionally from a central arterial twig.

The **Symptoms** arising from internal piles are often not very marked until hæmorrhage occurs; but there is usually a sense of weight or fulness about the anus, with sometimes pain, which is increased before and after defæcation. The patient feels as if a foreign body were present in the bowel, and the mass not unfrequently protrudes, giving rise to much pain and inconvenience owing to the grip of the sphincter until replaced by the patient. Sooner or later hæmorrhage is almost certain to be noticed, coming on at first after defæcation, and only a few drops being lost. After a time, however, the flow increases, and may continue to such an extent as to cause marked anæmia. If the case remains untreated, the pain and inconvenience increase; a blood-stained mucous discharge from the rectum is noticed, soiling the linen; reflex irritation of neighbouring organs is produced, and a condition of nerve prostration from pain and hæmorrhage may result. In cases where the piles result from portal obstruction, as in cirrhosis of the liver, the bleeding may be beneficial, and must not always be checked. Moreover, when the menstrual flow is diminished, a vicarious discharge of blood from the piles is sometimes observed.

Complications of Piles.—*Inflammation* of the venous ampullæ contained in piles leads to what is popularly termed an 'attack of piles,' although this is much less common with the internal than the external variety, and the fleshy form is that usually affected. The evidences of a localized phlebitis manifest themselves in the shape of a painful distension and swelling of the parts, which become blue in colour and exquisitely sensitive. They subside with or without suppuration; in the latter case a spontaneous cure may result, whilst in the former general blood contamination may follow, death from pyæmia having occasionally occurred. *Strangulation* of the piles by the sphincter ani may follow protrusion where reposition is not effected, the mass then becoming painful, tense, swollen, and livid in colour; inflammation running on to ulceration and even sloughing follows, the patient suffering meanwhile from sickness, pain, and toxæmia. Pyæmia is likely to ensue unless the case is effectively treated. as also pylephlebitis (*i.e.*, septic inflammation of the branches of the portal vein in the liver). On the other hand, a spontaneous cure may be effected. *Prolapse* may become chronic, and *fissure* of the anus develop.

The **Diagnosis** of piles from other swellings which occur in the neighbourhood is not difficult. From *prolapse* they are recognised by their irregularity, the swelling not being of a rounded smooth annular variety, as in the former case; the two conditions are, however, often associated. From *polypus* piles are distinguished by being multiple rather than single, by being softer and more compressible, by their situation close to the anus, and by the hæmorrhage being usually more marked. *Mucous tubercles* and *condylomata* are often mistaken for external piles, but are easily recognisable by being symmetrically placed, owing to infection of one lip of the gluteal fold from the other, by their moist surface, and their situation at a little distance from the anus. The consistency, appearance, and history of an *epithelioma* should effectually prevent any error in diagnosis.

It is important also to remember that blood may be passed *per anum* from many other conditions besides piles. In the latter case the blood is of a bright red, florid colour, and often coats the fæces, whereas if it originates higher in the intestinal canal it is dark or tarry in colour (*melæna*), and is more intimately mixed with the excreta. A digital examination of the rectum will also in the latter case eliminate the presence of piles.

The **Treatment** of internal piles is both general and local.

General Treatment consists in removing all possible sources of venous congestion, in regulating the bowels and assisting the functions of the liver. The latter may be effected by the judicious administration of natural mineral waters, such as Hunyadi Janos and Friedrichshall, or the use of some such mild aperients as the confections of senna and sulphur, or castor-oil. These may be given daily, whilst at the same time the food and drink of the individual are regulated, all excess of alcohol being avoided, and suitable exercise enjoined. In weakly and debilitated individuals it is advisable to adopt a more stimulating and tonic plan of treatment. Aloes should generally be avoided. When dependent on the pressure of a gravid uterus, but little more than attention to the regular action of the bowel can be done until the child is born.

Local Treatment in the earlier stages consists merely in *palliative* measures. Thus, the parts must be protected from injury and cold; only soft paper or cotton-wool used after defæcation; and, when protruding, the piles should be sponged with cold water and gently returned. An ointment containing an extract of witch-hazel (hamamelis), or the injection of a hazeline lotion (1 in 8) is also advisable, and bleeding from piles can often be arrested by this means. The ung. gallæ c. opio of the Pharmacopeia is recommended, but it is not so efficacious.

When there is much pain or bleeding, and the piles have attained some size, **Radical Treatment** by operation is necessary.

Care must be taken before advising it to ascertain the condition of the liver, as the bleeding may be beneficial in relieving hepatic congestion, and an operation is then injudicious and harmful. In all cases the bowels are thoroughly emptied by a dose of castor-oil given the night before, and an enema on the morning of the operation. The patient is placed in the lithotomy position, the perineum is shaved and cleansed, and the surgeon thoroughly stretches the sphincter by introducing the two index-fingers and then separating them forcibly, by this means bringing into view the whole of the diseased area of mucous membrane, which never extends beyond 2 inches from the anus. The following plans of treatment are those chiefly used:

1. *Removal by clamp and cautery*, as introduced by the late Mr. Henry Smith. The mucous membrane having been everted, as just described, each of the hæmorrhoidal tumours is grasped by a pair of ring-ended catch forceps, and thus temporarily secured; by this means the scope of the operation required can be readily gauged. The clamp is then applied to each mass successively in a direction corresponding to the long axis of the gut, great care being taken not to include the external skin. The clamp is tightened by the screw attached to its handle, and the projecting mass of the pile removed by scissors. The cut surface is then thoroughly seared by a cautery at a dull red heat, and the pressure of the clamp slowly relaxed, so as to ascertain that all bleeding has ceased. Any external piles may be snipped away as indicated above, the mucous membrane re-inverted, the parts dusted with iodoform, and a carefully graduated compress of antiseptic wool applied with a T-bandage. The parts will require to be bathed each day with some mild antiseptic lotion, and should be healed in ten to fourteen days. The use of the catheter may be necessary for the first forty-eight hours after a severe case, owing to retention of urine. The bowels should not be opened until the fourth or fifth day, and then a mild dose of castor-oil and an enema may be administered. It is better to allow the patient to sit on a commode for the evacuation of the bowels. From a very large experience of this operation, gained both at hospital and in private, we have no hesitation in maintaining that, if efficiently carried out, and combined with the use of a powerful and properly constructed screw-clamp, it is absolutely safe and free from danger, that any complications from sepsis, hæmorrhage, etc., are due to the carelessness of the surgeon, and not to the character of the operation, and that for all practical purposes it is the best means of dealing with internal piles.

2. *Ligature* is also an operation much in vogue for the treatment of piles, and, as now carried out with due antiseptic precautions, a large amount of success attends its use, although it is doubtful whether recovery is as speedy or painless as after the cautery. The hæmorrhoidal tumours are grasped by forceps, the mucous

membrane divided around them, and the base ligatured with silk; the mass is then cut away, and the ligature cut short, the knot being allowed to separate by subsequent ulceration.

3. *Crushing* by means of a powerful clamp has also been recommended by Benham, Allingham, and others, the base of the mass being thoroughly compressed, and the pile then cut away. We think it safer to combine such treatment with the styptic and antiseptic qualities of the cautery.

4. Where the veins of the lower inch or two of the mucous membrane are in a varicose condition, but no definite hæmorrhoidal tumours are present, *Whitehead's operation* may be employed. It consists in the total removal of this pile-bearing area in the same way as for excision of the rectum. An incision is made round the margin of the anus at the junction of the skin and mucous membrane, and the latter dissected up from the muscular coat of the bowel by successive snips of the scissors; it is then cut away, all bleeding-points are secured, and the lower end of the divided mucous membrane united by suture to the skin. Excellent results have followed such treatment in suitable cases.

Prolapsus Ani and Recti.

A certain tendency to eversion of the mucous membrane of the bowel is a constant and normal accompaniment of the act of defæcation; if, however, this becomes abnormally increased, the condition may be maintained after the evacuation of the bowels is concluded, constituting a condition of prolapse. At first only the mucous membrane is protruded, and this is known as an incomplete prolapse, or *prolapsus ani;* if, however, the condition persists, the whole thickness of the bowel may become involved, mucous membrane, submucosa, and even the muscular and serous coats, giving rise to a complete *prolapsus recti* (Fig. 330). The former condition is more commonly met with in adults, and the latter in children; but it must be understood that the latter is always preceded by an incomplete stage, limited to the mucous membrane, and that in adults a complete prolapse is occasionally observed.

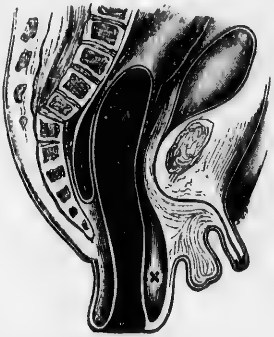


FIG. 330.—LONGITUDINAL SECTION OF COMPLETE PROLAPSUS RECTI. (TILLMANNS.)

X indicates the serous sac in the anterior wall due to protrusion of the peritoneum.

Causes.—1. It may be produced by a simple relaxation of the tissues, as met with in weakly individuals, and those who have been much exposed to the debilitating effects of residence in tropical climates, especially when chronic constipation or diarrhœa has caused the evacuation of the bowels to be accompanied by straining efforts. 2. Conditions which have led to chronic tenesmus or violent expulsive efforts, *e.g.*, piles, chronic constipation, diarrhœa, rectal irritation, as from worms in children, or diseases of neighbouring organs, such as vesical calculus, stricture, enlarged prostate, may also determine prolapse.

Symptoms and Diagnosis.—The anal orifice is occupied by a smooth rounded swelling, red or purplish in colour, covered by mucous membrane; this protrusion in the early stages can be readily replaced by a little pressure, but returns if the patient strains or coughs. When the swelling is of large size, reduction is increasingly difficult and painful from infiltration and fibrous overgrowth of the submucosa, and it is very liable to become inflamed and ulcerated from friction. Incontinence of fæces is also a common result. Where the whole thickness of the gut is protruded, the serous lining may accompany the tumour, but is usually limited to the anterior surface, and into the sac thus formed small intestine may pass, and even become strangulated (Fig. 330, X). The prolapse itself may also be constricted if allowed to remain for long unreduced; the mass is then livid, swollen, and intensely painful, and if left to itself may slough away, and thus lead to a spontaneous cure, although severe septic symptoms may supervene, and even perforative peritonitis.

There should be but little difficulty in recognising a prolapse; the only condition for which it can be mistaken is an intussusception protruding from the anus; in such, however, the finger or a probe can be inserted into the rectum by the side of the protruding gut, which is impossible with a prolapse.

Treatment.—In the earlier stages, all that is needed is the removal, if possible, of the cause of the tenesmus, *e.g.*, dilatation of a urethral stricture, removal of a vesical calculus, or the regulation of the bowels so as to check either chronic diarrhœa or constipation. When piles are present, they should be treated as described above, and the prolapse will, as a rule, subsequently disappear. Thread-worms must be dealt with by suitable means (*q.v.*). Beyond this, cold or astringent injections may be employed, *e.g.*, sulphate of iron (1 to 3 grains to 1 ounce), and it is advisable for the individual to acquire the habit of having the daily motion at bedtime. The prolapse is then carefully washed, reduced by pressure with the oiled fingers, and retained by strapping the nates together, particularly in children, or by applying some suitable pad and a T-bandage. The great hope of obtaining a cure in this way consists in never allowing the prolapse to remain unreduced for any length of time.

When such palliative measures fail, **Operative Treatment** must be undertaken.

In the slighter cases of incomplete prolapse (*P. ani*), it will suffice to diminish the size of the anal orifice by snipping away the folds of skin and mucous membrane which radiate from the centre of the patulous orifice, and allowing the wounds thus produced to cicatrize. In the worse cases it may be necessary, in addition, to remove strips of the mucous membrane in a longitudinal direction by means of the clamp and cautery; or a larger area of the posterior wall of the prolapse may be denuded of its mucous covering, and the edges brought together by deep stitches. Where such has failed, or is thought undesirable, the prolapse may be dissected away by incising the circumference of the anal orifice at the junction of the skin and mucous membrane, and turning down the outer layer of the mucous coat like a cuff. A finger inserted in the bowel suffices to draw down all the slack inner lining, and to ascertain that nothing is present but the two layers of mucous membrane. The whole of the prolapsed portion is removed by scissors, all bleeding-points being secured as divided; the upper edge of the mucous membrane is then united by suture to the cutaneous margin of the anal orifice.

In cases of total prolapse of the bowel (*P. recti*) in children, nothing but palliative treatment is generally necessary; but in adults a modification of the above described operation is required. The patient's buttocks are well raised, so as to prevent any protrusion of intestine if the peritoneal cavity is opened. The base of the prolapse is divided anteriorly on a level with the anus, the opening in the peritoneum plugged with a sponge, and the remainder of the mass removed by scissors, bleeding-points being secured as divided. The serous cavity is then carefully closed by sutures, and the divided end of the bowel united to the skin at the anal orifice. No motion is allowed to pass for a week, but the anal orifice and lower gut should be thoroughly washed out twice or thrice daily to prevent accumulation of septic material. Control over the bowel is usually slowly regained, and the after-treatment is likely to be somewhat prolonged.

In obstinate cases where the prolapse recurs again and again after operation, the sigmoid flexure should be cut down upon from the groin and anchored by sutures to the abdominal wall, or even a temporary colotomy performed.

CHAPTER XXXIV.

SURGICAL AFFECTIONS OF THE KIDNEYS.

Congenital Affections of the Kidney.—Many different malformations and displacements are met with affecting these organs.

The chief **Malformations** are as follows: (*a*) Complete absence of one organ. (*b*) Congenital atrophy of one kidney, it being represented by a mass of fatty tissue; in both cases the other organ is correspondingly enlarged and hypertrophied. (*c*) The kidneys may be fused together, either constituting one large organ in the median line, and more or less normal in shape, or sometimes constituting the so-called horseshoe-shaped variety. (*d*) Deep lobulation of the kidney, as in some animals, is sometimes seen, especially if the organ is displaced; occasionally this is carried to such an extent as to divide it into two or more portions. (*e*) The ureter and pelvis may be double, this malformation affecting the pelvis alone, or extending as far as the bladder. (*f*) The renal artery may arise from the aorta in two or more main branches.

The majority of these malformations are of very little clinical importance, except in the operation of nephrectomy, when they may necessitate a slight modification of the usual proceedings.

Congenital Displacement of the Kidney occurs about once in every thousand individuals, the organ being either depressed, so as to lie over the sacro-iliac synchondrosis or sacral promontory, or raised above its normal position. The left kidney is more frequently affected in this way than the right, and, when lying in the iliac fossa, the descending colon is usually displaced inwards, so that the rectum starts to the right of the middle line. The adrenal bodies retain their normal position, and do not move with the kidney.

Cystic disease, sarcoma, and hydronephrosis may also occur congenitally, and will in turn be described below.

Floating and Moveable Kidney.—The term **Floating Kidney** has been applied to a supposed congenital condition in which the organ is attached to the posterior abdominal wall by a meso-nephron or peritoneal ligament; it is, however, more than doubtful whether such an abnormality really exists. By **Moveable Kidney** is meant an acquired condition in which the kidney moves within the perinephric fatty tissue, which forms a loose capsule around it. It occurs more frequently in women than in men, and more often on the right than on the left side, partly because the renal vessels are longer on this side than on the other, and partly because the descending colon is more fixed than the ascending.

Causes.—Parturition accounts for many cases, firstly because of the sudden diminution of the intra-abdominal pressure, and secondly owing to the resulting pendulous and relaxed state of the abdominal muscles, especially if the patient too early resumes the erect posture, or undertakes physical work without efficient external support. Hence, it is more frequent among the poor than amongst the rich. It may also follow the removal of large abdominal tumours or rapid emaciation; whilst tight-lacing or traumatic influences may be responsible for some cases. It is frequently associated with that form of displacement downwards of the abdominal viscera which is known as Glenard's disease, or enteroptosis. This is probably due to accumulation of fæces in the transverse colon, whereby the omentum and other peritoneal ligaments become stretched, and in consequence the intestines, stomach, and even the liver, may slip downwards and become moveable. The right kidney participates freely in this displacement.

The **Symptoms** arising from a moveable kidney consist chiefly in pain referred to the back, or perhaps shooting along the ureter to the groin, testis or labium majus; it is increased by pressure or manipulation of the abdomen. Vomiting is a significant sign, and the surgeon should never omit to examine the loins in cases of obstinate vomiting with no apparent cause. Periodical exacerbations of these symptoms, with a temporary diminution in the amount of urine, result from kinking of the ureter; sudden relief, followed by an increased flow of urine possibly containing some muco-pus, indicates that the organ has returned to its normal situation. On examining the abdomen, a moveable tumour can often be observed with ease if the abdominal parietes are not loaded with fat, and on manipulation pain and vomiting may be induced. If the patient is lying in the prone position on a flat couch, a distinct loss of resistance is noticed external to the erector spinæ on the affected side.

Treatment consists in wearing an abdominal belt, suitably padded, or in the operation of nephrorrhaphy (p. 1001).

Injuries of the Kidney are usually due to crushes of the body, as between the buffers of railway cars, or when a cart passes over the abdomen, or from blows or falls. Considerable hæmorrhage follows, both into the substance of the kidney or its pelvis, and into the perinephric fatty tissue, and this even when the capsule has not been torn. The integrity of this structure is a point of considerable importance, since it limits to some extent the bleeding and prevents urinary extravasation; the kidney may be crushed to a pulp without any external hæmorrhage, and under these circumstances clots are likely to pass down the ureter, and may obstruct it and lead to its subsequent occlusion. When the anterior portion of the capsule is torn, the peritoneum may also be involved, and then evidences of intraperitoneal bleeding may manifest themselves, and, indeed, if the kidney is extensively lacerated, fatal hæmorrhage may result. Rupture of the posterior surface of the kidney opens up the retroperitoneal cellular tissue, which becomes infiltrated with blood and urine, and suppuration is almost certain to follow, resulting, perhaps, in pyæmia, or exhaustion later on from chronic septic poisoning.

The **Symptoms** produced consist in severe shock, combined with pain in the loin, shooting down into the testis or thigh, and increased frequency of micturition, the urine voided being usually mixed with blood. The amount of blood lost in this way varies considerably; in the slighter cases the hæmaturia is of short duration, but in more extensive lesions it may be so severe and so persistent as to threaten life. The passage of clots down the ureter gives rise to renal colic, and obstruction of that duct may lead to total suppression of the secretion on the affected side. The bladder may in some cases become greatly distended with clots, the blood coagulating after it has entered the viscus. Hæmorrhage into the perinephric tissues is indicated by the formation of a swelling in the loin, and laceration of the peritoneum is shown by distension of the abdomen and the existence of fluid within it. The development of a perinephritic abscess is recognised by fever, rigors, increased pain in the loin, and the usual phenomena of deep suppuration.

The **Treatment** usually required is to keep the patient quiet in bed, with an icebag applied to the loin; pain may be relieved by strapping the side or by applying a firm bandage. Persistent hæmorrhage requires the administration of ergot, tannic acid, or turpentine; but if it is threatening the patient's life, an exploratory incision is required, and, if need be, removal of the organ. Any distension of the bladder must be relieved, the clots being washed out through a large-eyed catheter. The occurrence of peritonitis or of a perinephritic abscess will call for suitable surgical measures, the injured viscus being dealt with according to circumstances.

Rupture of the Ureter is a rare accident, usually due to injury, but occasionally happening during pelvic operations, such as removal of the uterus. If it follows an injury, it may not be recognised at once, but extravasation of urine takes place, resulting in the formation of a perinephritic abscess, which may burst either externally or into the peritoneal cavity. A fatal issue is likely to follow the latter of these two conditions, whilst a urinary fistula in the loin may result from the former. Up to quite a recent period such an injury was irremediable, and nephrectomy was undertaken in order to prevent or remedy the conditions arising from the continued secretion of urine; if such a procedure is required, the sooner the operation is undertaken the better. A plan has now, however, been suggested for suturing the ureter, and it has already been followed by success in one or two cases. The lower end of the divided ureter is closed, the exposed mucous membrane being tucked in by sutures passing through the muscular coat; the upper end is then implanted into a longitudinal opening made in the side of the lower segment, and accurately stitched in position.

Inflammation of the Kidney and its Surroundings.—It is unnecessary to discuss the many varieties of inflammation of the kidney; they are dealt with in medical text-books. The only conditions we need describe are pyelitis and perinephritis.

Pyelitis is the term applied to an inflammation involving the pelvis of the kidney, the calyces, and perhaps the ureter. The chief causes from which it arises are: (1) The presence of a calculus; (2) tubercular disease, either starting primarily in the kidney, or extending upwards from the bladder; (3) extension of septic inflammation from the bladder and urethra (surgical kidney); (4) malignant disease of the kidney; (5) occasionally in floating or moveable kidney; (6) the ingestion of irritating drugs, *e.g.*, cantharides, turpentine, and occasionally cubebs or copaiba; (7) the presence of foreign bodies, such as needles, bullets, and parasites, *e.g.*, the *Bilharzia hæmatobia* or the *Strongylus gigas;* (8) a pyæmic embolus; and (9) possibly cold.

Whatever the cause, the pathological phenomena are the same, consisting in the lining membrane becoming hypertrophied, and secreting a muco-purulent, or even purulent, discharge. Owing to the swelling of the mucous membrane, the entrance to the ureter becomes blocked, and a certain amount of distension of the pelvis and calyces (hydronephrosis) follows. Where micro-organisms are present, as in cases due to extension from the bladder, ulceration of the lining membrane with interstitial nephritis usually results, and this may lead to a urinary abscess in the loin or to suppurative perinephritis.

The **Symptoms** of pyelitis consist of pain and tenderness over the affected kidney, increased frequency of micturition, and the intermittent discharge of pus in *acid* urine. The intermissions are due to the inflammatory swelling of the mucous membrane, which blocks the upper entrance to the ureter, and necessitates a certain amount of pressure of the urine and pus accumulated in the pelvis of the kidney in order to overcome the obstruction. Necessarily, where pyelitis follows chronic cystitis, the acid reaction of the urine is neutralized by the changes occurring in the bladder; in such cases a nocturnal elevation of temperature is usually noted.

The **Treatment** of pyelitis must be mainly directed to the cause. Where such is removable, *e.g.*, calculus or foreign bodies, an operation is advisable. In septic cases originating in the bladder, treatment should first be directed towards the latter viscus. If no cause is evident, the patient must be kept warm, his diet restricted to the simplest solids and bland fluids, and salol, alkalies, and sedatives prescribed. If these measures fail, the affected kidney should be explored.

Perinephritis, when recognisable, is always suppurative in nature, resulting either from septic wounds, or from ulceration involving the walls of the pelvis and calyces, or from the transmission of micro-organisms from the interior of a suppurating kidney or pelvis without any breach of surface. A perinephritic abscess may also arise from inflammation spreading from the intestine, pleural cavity, ribs, or elsewhere.

The **Symptoms** may be acute or chronic in nature. In *acute perinephritis*, signs of deep suppuration in the loin are produced, viz., an indurated painful swelling, associated with fever, and perhaps preceded by rigors. Fluctuation may sometimes be detected when pus has formed, but the abscess is often so deeply placed that it cannot be readily recognised at first; it tends to point at the side of the erector spinæ, or may burrow forwards between the abdominal muscles, and find an exit on the anterior abdominal wall. Occasionally it bursts into the peritoneal or pleural cavities, or into the intestine. If it comes to the surface, it is preceded by congestion and œdema of the skin. *Chronic perinephritis* gives rise to no characteristic symptoms until an abscess forms which is large enough to be felt.

Treatment in each case consists in evacuation of the pus through an incision at the outer border of the erector spinæ; the cavity is then carefully examined, and the cause of the suppuration, if possible, determined, and treated according to the requisites of the case.

Tubercular Disease of the Kidney occurs in one of three forms. (*a*) It may arise in the course of **acute general tuberculosis**, when miliary tubercles are found studding the organs, but giving rise to no special symptoms. Treatment, of course, is impracticable.

(*b*) It may **extend upwards** from a similar affection of the bladder, and then almost invariably involves both kidneys. The mucous membrane of the ureter becomes thickened and transformed into œdematous granulation tissue containing tubercles, and that of the pelvis and calyces is similarly affected; finally, the kidney substance itself becomes infiltrated with tubercular tissue spreading from the pyramids. *Clinically*, enlargement of both kidneys is noticed, arising partly from the deposit of tubercle and partly from the obstruction within the ureter. The symptoms caused by the renal mischief cannot at first be distinguished from those due to the vesical trouble. Perinephritic abscess occasionally follows, and the patient dies from exhaustion, septic absorption, or uræmia. Treatment in these cases is of no avail.

(*c*) **Primary Tuberculosis** of the kidney is generally unilateral, and commences as a deposit of tubercle in the cortex or at the base of one of the pyramids. A caseous mass forms, which may extend widely, causing disintegration of the kidney substance, or may burst into the pelvis and infect that cavity. A tubercular pyonephrosis follows, and the process spreads for some distance down the ureter, and even infects the bladder (Fig. 331). Suppurative perinephritis may also supervene, and give rise to an abscess which bursts externally.

The **Symptoms** are at first indefinite, the patient complaining of increased frequency of micturition and unilateral pain in the loin, neither of which conditions is improved by rest, remaining the same at night as in the day. The pain is generally of an aching character, and more or less constant, although exacerbations may occur. The urine usually contains a certain proportion of pus, in which on examination the *Bac. tuberculosis* can often be detected. Hæmaturia is not marked, even if present at all. On examination the kidney may be found to be slightly enlarged, but is not tender, except in the later stages, when it constitutes a tumour of considerable size.

The **Diagnosis** of primary renal tuberculosis is usually a matter of doubt, if the presence of bacilli in the urine cannot be demonstrated, since the symptoms are very similar to those of renal calculus. The history of the patient and of his family may be of importance, whilst the chief points of distinction are that the symptoms are less influenced by exercise or rest, and there is less hæmaturia or renal colic than when a calculus is present, whilst the kidney is usually not so tender on manipulation; of course, the condition is much less common than that of stone. In doubtful cases the final distinction is made by exploring the organ through an incision in the loin. The tubercular kidney is usually mottled in colour and pallid-looking, whilst hard, scattered, caseous nodules may be felt, which become fluid on pressure, or on incision give exit to caseous pus. The upper part of the ureter is

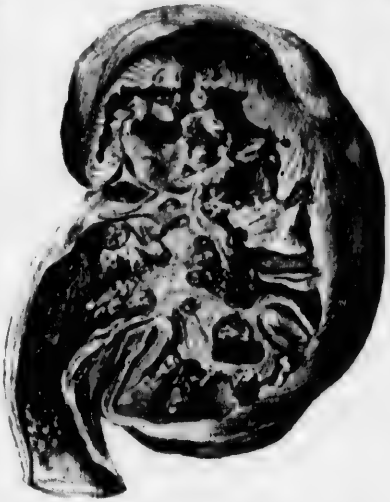


FIG. 331.—TUBERCULAR KIDNEY, SHOWING THICKENING OF MUCOUS MEMBRANE OF PELVIS AND URETER. (FROM SPECIMEN IN COLLEGE OF SURGEONS' MUSEUM.)

often somewhat thickened and indurated. In calculus the surface is uniformly even and dark red, or if any areas of softening are present, they are of a bluish-red colour; the pelvis and upper end of the ureter are usually lax and distended.

Treatment.—If on exploration of the kidney the disease is found to be strictly limited and the pelvis unaffected, it may be possible to treat it in the same way as tubercular affections elsewhere, viz., by scraping away the diseased tissue, careful purification of the cavity by pure carbolic acid, and plugging the wound thus formed. In other cases it may be possible to excise wedge-shaped areas of the renal cortex, securing the wounds by sutures. In the majority of instances, however, the disease will have spread much too extensively for such conservative treatment, the kidney practically consisting of a series of cysts filled with offensive pus. If the surgeon is tolerably certain that the other kidney is healthy, nephrectomy should be performed, care being taken to divide the ureter below the farthest limit of the disease. The occurrence of a perinephritic abscess necessitates an incision in the loin in order to evacuate the pus, and through this opening the kidney can be explored and, if necessary, removed.

Renal Calculus.—Renal Calculi are usually met with in individuals suffering from lithiasis, as indicated by the passage of sand or gravel in the urine. The general causes of this condition are detailed elsewhere (p. 1019). All renal concretions are primarily excreted in a crystalline form from the renal tubules, but under ordinary circumstances are sufficiently small to find their way into the pelvis of the kidney, and thence along the ureter to the bladder. If, however, they are obstructed in their onward course, either on account of their size or shape, or any narrowing of the tubules, they may become lodged in the kidney substance or in one of the calyces, and by the gradual deposit of the same material increase in size until large enough to give rise to symptoms (Fig. 332). Renal calculi are not often of great size, rarely exceeding that of a Barcelona nut; occasionally, however, the whole of the pelvis, and some of the calyces, may be occupied by a concretion, which takes the shape of the cavity in which it lies. When many calculi are present in the pelvis of the same kidney, they are usually faceted. Chemically they consist either of uric acid or urate of ammonium; sometimes, however, they are composed of oxalate or acid phosphate of lime.

The **Pathological Phenomena** connected with renal calculi vary with their size, shape, number, and position. If situated in the substance of the renal parenchyma, they give rise to but little change, being more or less encapsuled in a cavity lined by granulation tissue. When occupying the pelvis of the kidney, they set up pyelitis, and from the obstruction to the flow of urine, caused partly by the thickening of the mucous membrane, and partly by the calculus engaging the orifice of the ureter, produce dilatation of the pelvis of the kidney, and the phenomena described below as hydro- or pyo-nephrosis. If on account of their shape or size they become imprisoned in one of the calyces, ulceration of the wall and suppurative perinephritis may follow; the calculus may even find its way into the abscess cavity, and be discharged spontaneously or removed through the loin, a urinary fistula often resulting. If the calculus passes down the ureter, it gives rise to the symptoms of renal colic. When small and smooth, it usually reaches the bladder without much difficulty, and is then either voided with the urine, or remains as a vesical calculus. Occasionally, owing to its size or irregular shape, it becomes impacted in the ureter, giving rise to acute obstruction and the cessation of the urinary secretion on that side, followed by disorganization. If the kidney thus affected is the only one available for excretory purposes, the patient, if unrelieved, dies in a few days from suppression of urine. In other cases the stone ulcerates through the wall of the ureter, giving rise to a retro-peritoneal urinary abscess, or possibly to suppurative peritonitis. If the ureter is only partially obstructed by the calculus, the changes which take place in the kidney are more gradual, and result in hydro- or pyo-nephrosis.

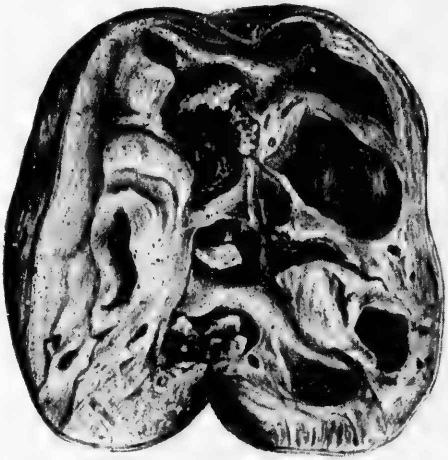


FIG. 332.—CALCULOUS KIDNEY. (COLLEGE OF SURGEONS' MUSEUM.)

The typical **Symptoms** arising from renal calculus are as follows: The patient complains of pain in the loin, more or less persistent, and often paroxysmal in nature, which is, however, always increased on exercise or jolting; it is frequently referred to distant regions, but most commonly follows the course of the genito-crural nerve, giving rise to pain in the front of the thigh, accompanied by retraction of the testicle; in the female it is also experienced in the labium majus. Sometimes it extends down the back of the thigh, and it has even been said that pain in the heel is pathognomonic! It is almost invariably associated with hæmaturia, and often pyuria, the amount of blood or pus being increased on exertion. Frequency of micturition is a prominent symptom, whilst if the pelvis is enlarged the kidney may be tender, and distinctly felt on palpation. If the calculus is lodged in the renal parenchyma, the urinary secretion may be but little influenced, although the characteristic pain is well marked; the patient also finds that at night he can only gain relief by lying on the affected side, and on manual examination the kidney, though tender, is not much enlarged. When the calculus lies in the pelvis or one of the calyces, the typical phenomena described above are produced; but it is then noticed that at night the patient lies on the sound side, since the organ is both enlarged and tender. On the other hand, it is an undoubted fact that stones even of large size may exist for years in the kidney without giving rise to any symptoms whatever.

The passage of a calculus down the ureter is accompanied with the symptoms known as **Renal Colic.** They consist of excruciating pain of a paroxysmal nature, which comes on suddenly, and is referred both to the loin and along the course of the genito-crural nerve. It is always associated with vomiting and severe shock, the patient often lying on the floor writhing in agony, with cold perspiration standing in beads on his forehead. The temperature is subnormal, and the pulse weak and rapid. Strangury is usually present, the patient suffering from frequent paroxysmal efforts to pass water, but only succeeding in evacuating a small amount, and that generally blood-stained. After lasting for a variable period, the pain suddenly ceases, as a result of the passage of the calculus into the bladder, or of its slipping back into the pelvis of the kidney.

The **Diagnosis** of renal calculus is often a matter of uncertainty in the absence of a history of the passage of gravel, or of the occurrence of renal colic. It is most likely to be mistaken for tubercular disease; the differential diagnosis between the two conditions has already been considered (p. 987). Some assistance may perhaps be obtained by the use of the X rays, and Mr. Henry Morris has pointed out that too long an exposure is undesirable, since the calculi are not very opaque, owing to their containing so much organic material. Phosphatic calculi are more easily detected than those consisting of oxalate of lime, whilst the uric acid stones are only seen with difficulty.

Treatment.—In the early stages treatment is directed to the cure of lithiasis (see p. 1019). The patient's diet and general habits of life must be suitably regulated, and he is instructed to make use of alkaline purgatives, such as Carlsbad or Vichy waters, or citrate of lithia and sulphate of soda may be administered in a mixture. Plenty of bland fluid should be ordered, such as boiled or distilled water, in the hope of dissolving the stone or assisting its onward passage to the bladder. Sometimes it may become encysted, if the patient is kept absolutely at rest; the symptoms will then gradually ameliorate, and finally disappear.

Attacks of renal colic are treated by the use of hot hip baths, warm drinks, and hypodermic injections of morphia: in the more severe cases chloroform must be administered.

If, in spite of the above-mentioned measures, the pain persists or increases in amount, or if one kidney is considerably enlarged and very tender, an *exploratory operation* is required, especially if a considerable amount of blood or pus is being passed in the urine, and the patient's temperature raised. It must also be undertaken if a perinephritic abscess forms or a calculus becomes impacted, particularly when only one kidney is present. A few cases are recorded when, after removal of one kidney, the other ureter became obstructed by a calculus, which was successfully removed by operation; if left to itself, death must have resulted. Pain in both kidneys is no contra-indication to operation, since there is no objection to exposing and even removing calculi from both organs; it must not be forgotten, however, that sympathetic pain in a sound kidney may be induced by calculi on the opposite side. Naturally, the organ in which most pain is complained of is dealt with first. The constant passage of gravel, moreover, need not deter one from operating, since when once the kidney has been relieved by removal of the larger masses, the tendency to recurrence may be checked by suitable diet or drugs. The amount of urea excreted daily should always be estimated in these cases, and if it is much diminished no operation should be undertaken. For details of the technique of nephro-lithotomy, see p. 999.

Where the organ is totally disorganized nephrectomy may be called for, but such treatment is not always advisable, especially when sinuses have resulted from a suppurative perinephritis. In such cases the renal tissue has often entirely disappeared, and disintegrating calculous material may occupy the pelvis, which is surrounded by a mass of dense fibro-cicatricial tissue, the removal of which is impracticable and even dangerous. All that should be attempted is the extraction of the stone and the purification of the cavity; the patient must resign himself to the inconvenience of a suppurating sinus in the loin.

Hydronephrosis is a condition characterized by distension of the pelvis and calyces with urine, as a result of some obstruction to its exit.

Causes.—(i.) It may be, though very rarely, *congenital* in origin. It must be borne in mind that the body of the kidney is developed from the metanephros, and that the ureter unites subsequently with it to form its excretory duct; if such union is defective, hydronephrosis results. It is, however, more frequently due to an impervious condition of the urethra or to the existence of a membranous septum therein; both kidneys are then necessarily affected. The amount of distension in some of these cases is such as to seriously interfere with parturition until the abdomen has been tapped. The infants are often born dead, or succumb shortly after birth. (ii.) *Acquired* forms of obstruction are by no means uncommon, and may be arranged under the following headings: (*a*) Blocks within the urinary passages from the presence of stones, parasites, foreign bodies, or even blood-clot; (*b*) changes of structure affecting the walls of the urinary passages, *e.g.*, inflammatory swelling of the mucosa, cicatrices, stenosis, or tumours; (*c*) kinking of the ureter in cases of floating kidney; and (*d*) the pressure of extrinsic tumours or cicatrices. Hydronephrosis may be unilateral or bilateral; in the former case the obstruction arises within the ureter, or from some vesical condition involving its entrance into the bladder; in the latter case the cause must be generally looked for below this spot.

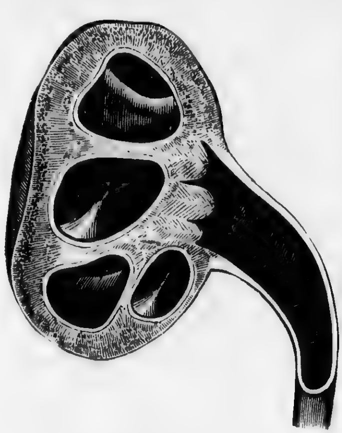


FIG. 333.—HYDRONEPHROSIS. (FROM SPECIMEN IN BRISTOL HOSPITAL MUSEUM.)

It must be clearly understood that a sudden and absolute block never leads to hydronephrosis. Should it occur as the result of impaction of a calculus in one of the ureters, the secretion on that side is totally suppressed as soon as the tension within the pelvis and calyces is sufficiently high. Should, however, the obstruction be incomplete, so that some of the urine escapes, and thus the pressure is relieved, hydronephrosis develops. Sudden and complete occlusion of the urethra likewise results in dilatation of the bladder, and rupture either of that viscus or of the urethra, whilst a gradually increasing obstruction is always likely to lead to hydronephrosis.

Pathological History.—The earliest result of obstruction to the flow of urine consists in dilatation of the ureter and pelvis, which is soon followed by expansion of the calyces. The pyramids are flattened, and the cortex expanded and thinner, so that the whole kidney looks larger than usual. A certain amount of interstitial infiltration of the cortex is always present; the urine secreted in the early stages is usually abundant and of a low specific gravity.

As the obstruction continues, the renal tissue becomes more and more atrophied, until finally it disappears entirely, the kidney being represented by a thin-walled multilocular cyst. At any stage septic phenomena may supervene, giving rise to pyonephrosis (*vide infra*).

The **Clinical History** varies considerably with the method of onset and the cause of the trouble. Frequently all that happens is a slight painless enlargement of the affected organ; if both are involved, there may be at first some increase in the amount of urine secreted, which is pale, limpid, and of a low specific gravity; after a time the quantity diminishes, and finally anuria and uræmia may follow, especially if septic changes supervene, as is so commonly the case. When only one kidney is affected, the excretion may remain normal in quantity and quality, owing to compensatory hypertrophy of its fellow. Not unfrequently a fluctuating swelling of considerable size is produced by hydronephrosis; it presents all the physical signs of a renal tumour (see p. 995), and its formation is often associated with pain, vomiting, and increased frequency of micturition. Finally, a perinephritic abscess may develop, owing to ulceration of the pelvis or ureter, and the cyst may thus discharge through the loin. Occasionally the size of the tumour varies considerably from time to time, owing to the obstruction being temporarily overcome by the pressure of retained urine behind it.

The **Treatment** of hydronephrosis should in the first place be directed to removal of the cause, if practicable, and where the obstruction exists in the prostate or urethra, no other treatment is feasible. Unilateral hydronephrosis must be dealt with by aspiration as a temporary measure; but this is rarely satisfactory, and usually needs to be followed by an exploratory incision (nephrotomy), by means of which it may be possible in a few cases to reach and deal with the obstruction. In the majority, however, the block is situated so low down that it cannot be reached, and then nephrectomy can be undertaken.

Pyonephrosis is the name applied to a distension of the pelvis of the kidney when associated with suppurative pyelitis. It is always secondary, either to pyelitis or to hydronephrosis. In the former case, the inflammation of the ureter causes partial obstruction to the flow of urine, and hence leads to dilatation; in the latter, suppuration extends to the previously dilated pelvis from the bladder.

Pathological Conditions.—The lining membrane of the pelvis is inflamed, thickened, and perhaps ulcerated. A considerable amount of decomposing urine, mixed with muco-pus, is always present in the dilated pelvis and calyces, and rugged calculi or tubercular masses may also be found. As a result of the absorption of toxic compounds by the lymphatics in the flattened-out pyramids, a subacute interstitial nephritis is caused, which may even lead to the formation of abscesses in the kidney substance. Bacteria sometimes find their way into the tubules, giving rise to a suppurative tubulo-nephritis. A certain amount of perinephritis is always associated with this condition.

The **Clinical Signs** of pyonephrosis consist in enlargement of the organ, which is tender on palpation, whilst more or less pain is present in the loin. The temperature of the patient is usually somewhat raised, especially at night, from the absorption of septic products; the patient steadily loses ground, and becomes emaciated; the tongue is dry, the appetite diminished, and nausea is sometimes present. The urine is usually scanty in amount, and loaded with muco-pus, which may be constant or intermittent. If both kidneys are involved, the excretion of urine gradually diminishes, leading to a fatal issue from uræmia, unless the patient dies previously from toxæmia or pyæmia.

Treatment.—Where both kidneys are affected as a result of some urethral or prostatic affection, no special treatment directed to the kidneys is feasible; but if the condition is unilateral, and not secondary to disease of the lower urinary organs, nephrotomy should be undertaken, and any removable cause dealt with. Failing this the cavity may be drained, or even nephrectomy performed.

Surgical Kidney is a somewhat vague term, employed to describe a condition of that organ which arises as a complication of some obstruction or inflammation of the lower urinary passages. It is due partly to backward pressure, partly to the extension of septic inflammation. The former cause leads to hydronephrosis, the latter to pyonephrosis, and the phenomena characteristic of these conditions are therefore present. Should the obstruction be satisfactorily treated without delay, the renal affection may almost completely disappear, although the kidney is often left somewhat contracted and granular from the cicatrization of the interstitial infiltration already described; if, however, sepsis is present, the outlook is much more serious, as pyelitis may persist in spite of treatment.

In some such cases, symptoms of an acute character occasionally manifest themselves, either arising spontaneously, or resulting from some surgical procedure, such as catheterism or operation. They are possibly produced by acute reflex congestion of the kidney, or more probably by the extension of septic mischief along the mucous membrane of the ureter, owing to the lymphatics of the bladder and ureter being continuous; under such circumstances, innumerable miliary abscesses may be found studding the mucous membrane, whilst the kidney itself passes into a condition of acute interstitial suppurative nephritis. In the slighter cases, the so-called 'urethral fever' is produced, characterized by the occurrence of a rigor, which passes off in a short time. In others the rigor may be repeated, the temperature remaining elevated for some days, and then gradually falling; but in the most severe attacks, rigors and hyperpyrexia persist, and a fatal issue follows, partly from uræmia, partly from toxæmia, or even from pyæmia. Nausea and vomiting are present from the first, whilst the urine is always scanty and blood-stained, or there may be a total suppression of the secretion.

The **Treatment** of surgical kidney is always directed towards the cause of its production. When this is removed, the renal phenomena usually disappear, unless confirmed suppuration is present. The greatest care must be employed in the passage of instruments through a stricture, and it is often advisable to make use of soft elastic catheters rather than silver ones, less irritation being caused by the former than by the latter. An aseptic condition of the instruments is especially essential. For the rigor following catheterism, the patient must be kept warm, plenty of hot diluent drinks ordered, and quinine (2 grains) and opium (½ to 1 grain) administered in a pill, although the latter drug must be sparingly used if any evidences of uræmia are existent. During the continuance of febrile symptoms, the skin and bowels are freely acted on, and a milk diet prescribed, although a certain amount of stimulant may be given if necessary; all operative measures must be avoided, as they are almost invariably fatal. Should suppression of urine ensue, the loins should be cupped in the hope of relieving renal congestion, a free action of the bowels obtained by the use of watery purgatives, and the patient made to sweat freely, either by the use of hot-air baths or by the injection of pilocarpine. Uræmic symptoms may sometimes be relieved by copious and repeated intravenous injections of normal saline solution, which encourage diuresis and a watery diarrhœa; several successful cases treated in this way have been recorded.

Tumours of the Kidney.—The **General Characters** of renal tumours are as follows: A swelling is noticed in the loin, which is shaped more or less like the kidney, a notch being occasionally felt on the inner border, and the outer margin being rounded. The flank is always dull on percussion, the note remaining unaltered whatever the patient's position, and intestine never finding its way behind the tumour. The passage of the colon in front of the kidney not unfrequently gives rise to a band of resonance over its anterior surface; the bowel, however, soon gets pushed aside by the growth of the tumour. The mass moves slightly on respiration, though less distinctly than the liver or spleen; and no pedicle can be felt passing down towards the pelvis.

The different varieties of tumour which may originate in the kidney may be classified as the *simple* and the *malignant*. Several cystic conditions also occur.

The **Simple** tumours of the kidney are:

1. **Cystic Disease** (or, as it has been termed, adenoma of the kidney), which may be congenital or acquired. It is not unfrequently bilateral, especially when congenital, and consists in an excessive development of interstitial tissue, usually of an ordinary fibro-cellular nature, resulting in compression of the tubules, which become distended into cysts, varying in size, but rarely exceeding that of a cherry; they are lined with epithelium, which is generally flattened, and filled with a limpid fluid containing urea, and perhaps cholesterine. The cysts are often very numerous, and may project from the surface of the kidney as nodular elastic outgrowths. The pelvis remains unaffected until the later stages of the disease (Fig. 334). Generally the whole kidney is involved, and may attain enormous dimensions;

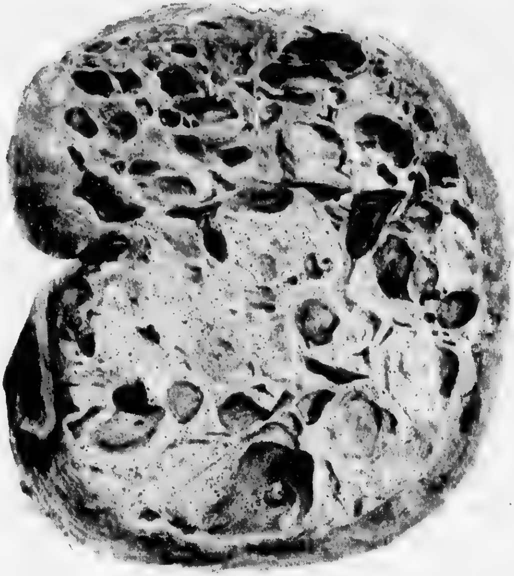


FIG. 334.—CYSTIC DISEASE OF KIDNEY. (KING'S COLLEGE MUSEUM.)

but occasionally the growth is limited to one portion of the organ. The early symptoms are simply those of pressure, but at a later stage the secretion of urine is interfered with to such an extent as to produce uræmia. The tendency of this affection to affect both kidneys prevents any hope of benefit from operation.

2. **Papilloma** of the renal pelvis is a rare condition, characterized by the development within its cavity of a villous mass, identical in structure with that met with in the bladder. It has usually been observed in elderly people, and the chief, if not the only, symptom is excessive hæmaturia. It cannot be diagnosed with certainty, but if found in an exploratory operation, it can be removed with success.

3. Occasionally tumours of a considerable size are found growing from the kidney, similar in structure to the zona fasciculata of the **adrenal** bodies. They are looked on as **adenomata** growing from accessory and misplaced adrenals; the renal parenchyma is normal in texture, though stretched over the new growth. When diagnosed, they may be removed together with the kidney, and the results are usually satisfactory.

Malignant tumours of the kidney may be divided into:

1. The **Sarcomata of Infants**, which usually originate congenitally, but may be acquired within the first few years of life. They are encapsuled, the kidney substance being spread over them, and consist of round or spindle cells, the latter often showing a cross-striation, resembling that of muscular fibres (myo-sarcomata). They grow to a great size, and may affect both organs, but pain and hæmaturia are absent. Death results from general dissemination, or may follow mechanical obstruction to the circulation, as by the detachment of a sarcomatous embolus, which travels upwards and blocks the pulmonary vessels.

Treatment by nephrectomy has given most unsatisfactory results, recurrence within a short period occurring even in those few cases which escape death from shock. When both kidneys are affected, nothing can be done.

2. The **Sarcomata of Adults** occur between the thirtieth and fiftieth years, and are of the spindle-celled variety. Only one kidney is generally involved, giving rise to a rapidly growing swelling, associated with pain and hæmaturia. Calculi are often found in the pelvis of such organs. Secondary deposits form in the viscera, and death usually results from exhaustion. The results of nephrectomy have not been very encouraging.

3. **Carcinoma** is an uncommon form of tumour in the kidney. It presents the same clinical features as a sarcoma, and can only be recognised on microscopic examination. One symptom, however, requires special notice, since it is extremely suggestive of the presence of cancer, viz., the development of a varicocele. It is due to the pressure of enlarged and cancerous lymphatic glands upon the roots of the spermatic veins, and hence, whenever an

elderly person develops a varicocele, a careful examination of the kidney on the affected side should always be instituted.

Various **Cystic Conditions** of the kidney must be noted in addition to the general cystic disease, already described.

(*a*) **Hydatid Disease** affects the kidney, as it may involve any other tissue in the body. It starts either beneath the capsule or in the glandular substance; in the former case it is likely to form a rounded projection, which may be detected on palpation of the loin; in the latter it expands, or even destroys, the whole of the glandular tissue, and may burst into the renal pelvis, the cysts being passed along the ureter, accompanied by more or less colic. Suppuration of the cyst may complicate matters, but, unless the cyst has ruptured into the pelvis, diagnosis is scarcely possible apart from an exploratory incision.

Treatment consists in cutting down on the kidney, and enucleating the mass, if possible. Failing this, drainage may be undertaken, and in bad cases nephrectomy may be necessary.

(*b*) **Dermoid Cysts** have also been found.

(*c*) **Serous Cysts** are occasionally met with, arising possibly as a result of obstruction to some of the ducts. Rounded swellings, single or multiple, are produced, growing outwards from the cortex, and containing a thin fluid with a small amount of albumin and saline substances in solution. They give rise to no symptoms except from their size, and rarely require treatment other than simple aspiration or drainage.

(*d*) Not unfrequently a number of small cysts develop in connection with chronic granular nephritis, but they are of no clinical importance.

Operations on the Kidney.

The kidneys are placed on either side of the middle line, and extend from the 11th rib above, to midway between the last rib and the iliac crest, the right kidney being somewhat lower than the left, owing to the presence of the liver. The hilus is situated opposite the spinous process of the first lumbar vertebra, and the upper ends of the organs are nearer to the spine than the lower.

The kidneys may be exposed by two chief routes, viz., the abdominal and the lumbar.

The **Lumbar** incision (Fig. 335, B) commences at a point corresponding to the outer border of the erector spinæ, and ½ inch below the last rib, extending downwards and outwards in the direction of the fibres of the external oblique for about 4 or 5 inches towards the anterior superior iliac spine. The posterior portions of the abdominal muscles and the fascia lumborum are divided *seriatim*, and the fatty tissue surrounding the kidney is thus easily reached and opened.

The **Abdominal** incision is made along the linea semilunaris, which is divided, and the peritoneal cavity opened. If the colon lies over the kidney it is displaced inwards, and held aside, as also the other intestines, by cloths soaked in warm carbolic lotion, or by Maunsell's intestine retractor; the peritoneum covering the posterior abdominal wall is incised to the outer side of the colon, and the organ thus exposed.

A third method has been advocated by some surgeons, known as the **Lateral** or **Lumbo-abdominal**. The incision extends vertically from the tip of the last rib to the iliac crest, and, if necessary, a cross-cut is made backwards at right angles to it. The peritoneum is stripped forwards from the kidney, the operation being thus retroperitoneal. The advantage over the ordinary lumbar incision has, however, yet to be demonstrated.

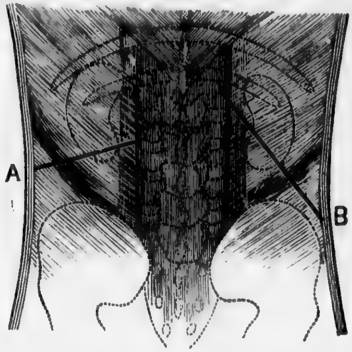


FIG. 335.—DIAGRAM TO ILLUSTRATE LUMBAR INCISIONS.
A, For lumbar colotomy; B, for exposing the kidney.

The following are the chief operations undertaken upon the kidney:

1. **Nephrotomy** consists in exposure of the kidney, exploration of its substance, and, if need be, incision into it for the removal of some abnormal condition. It should generally be undertaken through the loin. When exposed, the kidney is partially freed from its connections, and drawn up into the wound. Its substance is then carefully palpated between the fingers, any abnormal softening or hardening being noted. It may next be explored with a fine round needle, such as is used for knitting. Care must be taken not to mistake the sensation imparted to the fingers by striking the pyramids with the needle for a stone. Finally, if nothing abnormal is detected, an incision should be made through the convex border of the kidney substance into the pelvis. Free hæmorrhage follows such a proceeding, but soon stops when the finger is inserted. This incision through the

renal parenchyma must always be undertaken in preference to one through the pelvis, since the latter heals with difficulty, and is liable to leave a fistula. The pelvic cavity is then carefully explored by the finger, and the upper part of the ureter examined by a probe. Should a stone be detected, it may be removed by dressing forceps or a scoop, as also any foreign body; a papillomatous growth can be scraped away, and the base carefully cauterized, whilst if the operation is performed in order to drain a suppurating pelvis, a drainage-tube is inserted into its interior. The wound in the cortex is usually secured by one or more catgut sutures passed through its substance, unless the condition of the lining membrane of the pelvis renders such a step inadvisable, or if permanent drainage is required. The external wound may then be closed, the muscular planes being carefully united by a series of buried sutures.

2. **Nephrectomy**, or total removal of the kidney, is performed for the following conditions: (*a*) For tubercular disease, when conservative measures are impracticable, or when the pelvis and ureter are involved; (*b*) for calculous pyonephrosis, when the renal parenchyma is disintegrated; (*c*) for hydronephrosis, when palliative measures or drainage have failed to give relief; (*d*) for malignant disease; (*e*) for traumatic lesions, such as disintegration or rupture, especially if complicated by laceration of the peritoneum; (*f*) for some cases of rupture of the ureter; (*g*) finally, it has been proposed by Reginald Harrison to remove one kidney in the treatment of ectopia vesicæ (p. 1004).

Before undertaking the excision of any kidney, however diseased, it is essential that the surgeon should satisfy himself as to the existence of another, and also, if possible, ascertain that it is capable of undertaking the increased duties which will subsequently fall upon it. Many different plans of doing this have been suggested, but it is often difficult to be absolutely certain. In doubtful cases the best course is to perform an exploratory laparotomy, by means of which not only can the existence of a second kidney be determined, but also its condition investigated, and the size of the renal artery ascertained. An examination of the diseased organ can also be made; if it is of large size, the operation may be completed from the front at once; but if it is small enough to be dealt with from the loin, the abdomen is closed, and the nephrectomy put off for a week or ten days, until the first incision has healed. It is sometimes possible to prove the existence of a second kidney by means of the cystoscope, little gushes of urine being seen to escape from the ureter; whilst in females catheterism of the ureter is practicable. Another method suggested is to compress the orifice of one ureter and collect the urine from the other; but these plans cannot be depended on.

Nephrectomy may be undertaken through the abdomen or through the loin; but sundry combinations or modifications of these operations have been recommended by various authorities.

The *Abdominal Operation* is chiefly utilized when the organ is much enlarged, on account of the readier access obtained, especially to the pedicle. The main objection lies in the fact that the peritoneum is opened, and thereby exposed to septic contamination, especially when the pelvis and the upper part of the ureter are distended with decomposing pus, as is frequently the case. Moreover, no satisfactory drainage is obtained for the cavity left by the removal of the organ, unless a counter-opening is made through the loin. Of course, a great advantage, as before stated, is that the other kidney can be first examined, and its condition ascertained. As to the technique, after exposing the kidney in the manner already described, the organ is freed from its adhesions to surrounding tissues, the surgeon being careful to keep outside its capsule. Special precautions must be adopted in dealing with the posterior aspect of the tumour, particularly on the right side, where it is occasionally adherent to the inferior vena cava. The mass is now lifted from its bed, and its pedicle, consisting of the ureter and renal vessels, isolated. These latter are secured separately by ligature and divided, a clamp being applied to the distal ends. The ureter is dealt with in the same way, small pieces of sponge being packed round so as to receive any secretion which may escape; the exposed mucous membrane in the portion which is left is purified by the application of pure carbolic acid. The kidney thus freed is removed, and the wound in the posterior parietal layer of the peritoneum brought together, if possible, by sutures, provision for drainage having been previously made either through the loin or by the insertion of a gauze drain from the front. The abdominal cavity is carefully cleansed from all blood-clot, and closed in the usual way. Considerable shock is always experienced from this operation, and the death-rate from this cause is somewhat high.

The *Lumbar Method* can only be employed when the kidney is not much enlarged. The organ is exposed by the incision already described, enucleated from its surroundings, and the pedicle dealt with as in the abdominal operation. If the condition of the opposite organ has not previously been ascertained by laparotomy, Kocher recommends that the peritoneum should be incised at the outer margin of the wound, so as to enable the hand to be inserted across the middle line, and thus allow an exploration of the opposite loin, and there is no reasonable objection to this proceeding.

3. **Nephrorrhaphy** is the title given to the operation for fixing a moveable kidney. The usual lumbar incision is adopted, and if the organ is found to move freely within its fatty capsule, this latter should be always drawn into the wound, and a considerable portion excised. Two or three silk stitches of medium thickness

are then passed through the muscles, and also through the cortical portion of the kidney, securing a good hold of it. By tying these the kidney is fixed to the posterior abdominal wall, and the wound is then closed. The results of this operation have not always been satisfactory, the symptoms returning. It appears from experiments that sutures passed through the renal parenchyma are very quickly disintegrated and removed; and hence, although the kidney may seem to be efficiently immobilized at the completion of the operation, it readily becomes loose again. To obviate this it has been suggested to leave the parietal incision open, merely stuffing it with gauze, so that a firm mass of cicatricial tissue may develop, extending from the kidney to the surface, and thus anchoring it. Some, again, have recommended that the true capsule should be partially stripped off and stitched to the abdominal parietes, the raw surfaces thus formed uniting securely, and fixing the organ; whilst others advise the isolation of one of the tendons of the spinalis dorsi, which is passed from above downwards under the capsule, as a support on which the kidney is slung. (See report in *Clinical Journal*, February 5, 1896.)

CHAPTER XXXV.

BLADDER AND PROSTATE.

Congenital Affections of the Bladder.

1. **Ectopia Vesicæ**, or **Extroversion of the Bladder**, is the term given to denote total absence of the anterior wall of the bladder and of the lower portion of the abdominal parietes, as a result of which the mucous membrane of the posterior vesical wall is exposed and rendered somewhat prominent by the pressure from behind of the abdominal contents (Fig. 336, B). This surface is usually irregular, and covered with papilliform processes; the orifices of the ureters (U, U) are easily recognised below, urine being occasionally emitted from them in forcible jets. The condition is necessarily one of the greatest discomfort, not only from the constant dribbling of urine causing excoriation and eczema of the thighs and surrounding parts, but also from the pain and irritation due to friction of the clothes against the exposed mucous membrane. The symphysis pubis is always absent, and the horizontal ramus of the pubic arch terminates on either side in the inguinal region (H, H). The

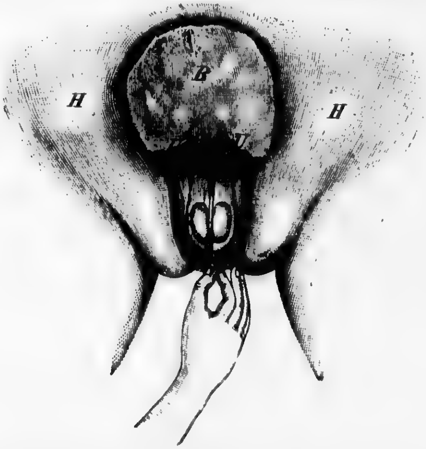


FIG. 336.—ECTOPIA VESICÆ. (TILLMANNS.)

B, Exposed mucous membrane of bladder; U, U, orifices of ureters; H, H, projections of pubic rami on either side.

innominate bones are usually rotated outwards, and the sacrum is convex anteriorly from side to side instead of being concave. In consequence of this pelvic malformation, the patient's gait and powers of progression are considerably impaired. The penis is cleft along the upper wall, and in a condition of complete epispadias; it is drawn upwards and backwards over the trigone, so that it requires pulling down (as seen in the illustration) to expose the ureteral orifices. The testes are often found in the inguinal canal, or, if in the scrotum, are accompanied by a congenital hernia. No umbilicus is present. The condition is due to impaired development of the anterior wall of the allantois and the lower segment of the abdominal parietes. At birth the lower portion of the umbilical cord is expanded over the raw surface, constituting the anterior vesical wall. When the cord separates, the posterior vesical wall is necessarily exposed.

The **Treatment** of this distressing malformation is not very satisfactory. The majority of the cases are treated by the application of a urinal, but, unfortunately, the instruments hitherto devised are not particularly efficient. Various operative measures have also been practised with the object of covering the exposed surface, and forming, if possible, a reservoir in which the urine may be retained. (*a*) Trendelenburg's operation consists in division of the sacro-iliac ligaments from behind, so as to enable the lateral halves of the pelvis to be compressed together. By this means the posterior vesical wall is thrown backwards and its tendency to protrude lessened. The wounds are allowed to granulate, and, if successful, the bladder wall finally lies at the bottom of a sulcus, which can usually be covered over by a plastic operation without much difficulty. A new bladder is thus formed, and the patient's condition considerably ameliorated. The main objections to this method are that it involves a very severe operation, and also leads to a further weakening of the pelvic arch, the integrity of which is already much impaired by the absence of the pubic symphysis. (*b*) Plastic operations without interfering with the pelvis have been introduced and practised by the late Professor John Wood, Thiersch, and others. For full details, we must refer to larger text-books. Suffice it here to state that a skin flap is turned down from the anterior abdominal wall above the breach of surface, and sutured on either side to the margins of the defect. The cutaneous surface of this flap constitutes the anterior wall of the newly-formed bladder, if such it can be called, whilst its raw outer surface is covered in either by flaps derived from either side, or by undercutting the neighbouring skin and sliding it inwards to the middle line, where it is united by sutures, as suggested and successfully carried out by Mr Boyce Barrow. The after-treatment is always prolonged and tedious, and the patients are likely to experience much subsequent inconvenience owing to the growth of hairs, which become encrusted with phosphates, from the under surface of the abdominal flap.

It has been recently suggested by Mr. Reginald Harrison to deal with this distressing condition by removal of one kidney, and transplantation of the ureter of the opposite kidney into the loin after a sufficient interval has elapsed to allow of its compensatory hypertrophy. By this means the exposed mucous membrane is able to dry up, and the urine escaping from the loin is readily collected by a suitable urinal. The proposal seems to us distinctly good, and in the case reported by Mr. Harrison the result attained was on the whole satisfactory.

2. An **Umbilical Urinary Fistula** is sometimes met with as a result of imperfect closure of the urachus.

3. Occasionally in cases of malformation of the rectum the **Primitive Cloacal Condition** may in part persist (see p. 958).

Traumatic Affections of the Bladder.

Rupture of the Bladder may be produced in several ways: (1) It may be due to direct violence applied to the lower part of the abdomen, especially when the viscus is distended. (2) It may complicate a fracture of the pelvis, either as a direct result of the violence, or from penetration of a spicule of bone from the os pubis. (3) The bladder may be opened by a penetrating wound of the abdomen. Apart from traumatic lesions, rupture may occur from simple over-distension, especially if destructive ulceration of its walls, as in malignant disease, is present; or it may follow ulceration of a saccule if it contains a phosphatic concretion.

Rupture of the bladder is divided into two main classes, according to whether or not the peritoneal cavity is opened. The peritoneum covers the upper and back part of the viscus, being reflected anteriorly along the urachus, laterally along the obliterated hypogastric arteries, and posteriorly on to the rectum.

Intraperitoneal Rupture involves the posterior or superior portions of the viscus, and is the variety most frequently met with. The symptoms produced are severe shock, associated with hypogastric pain of a burning nature. The patient experiences a constant desire to micturate, but, as a rule, nothing is passed, except perhaps a little blood. Peritonitis soon follows, running a rapidly fatal course, especially if efficient treatment is not adopted. On passing a catheter the bladder is usually found empty, or possibly a little blood-stained urine may be withdrawn; if, however, the instrument is insinuated through the rupture into the peritoneal cavity, a considerable quantity of blood-stained urine can be evacuated and the point of the catheter may be felt under the anterior abdominal wall. A useful diagnostic sign consists in injecting a measured amount of boric acid lotion into the bladder, and noting how much of it returns; when a rupture exists, some considerable discrepancy will probably be noted between the two quantities.

The **Treatment** of these cases consists in immediate laparotomy; the fluid within the peritoneal sac is removed by sponges, and the wound in the bladder clearly demonstrated, preferably with the patient in the Trendelenburg position (p. 1036), so as to allow the intestines to gravitate towards the diaphragm. The rent is then carefully closed by means of a row of Lembert's sutures, which should always extend a little beyond each extremity of the wound. Possibly a drainage-wick or a Keith's tube may need to be inserted for a few hours, so as to remove any exudation. The layers of the abdominal parietes are then successively closed, and the patient put back in bed. The urine is either drawn off at regular intervals, or a catheter may be tied in the bladder, the urine being syphoned by an attached rubber tube leading into a vessel placed beneath the bed.

Extraperitoneal Rupture of the bladder involves its anterior wall or base. The urine finds its way into the pelvic cellular tissue, and, if unhealthy, at once gives rise to a most virulent form of suppurative pelvic cellulitis, which is usually fatal from toxæmia or pyæmia. Abscesses tend to point either above the pelvic brim or in the perineum. The treatment consists in free incisions through the perineum, or above the brim of the pelvis. If the urine is healthy and uncontaminated with bacteria, and is not allowed to remain long in contact with the tissues, the prospects of recovery are good.

Foreign Bodies introduced into the bladder from without are of various natures, such as portions of catheters or bougies, pins, etc. They give rise to symptoms of chronic cystitis and usually become encased with phosphatic deposit. They should be removed as early as possible with a lithotrite, but if of large size, or thickly covered with phosphates, must be treated by perineal or suprapubic cystotomy. In the female digital dilatation of the urethra is the best means of gaining access to the interior of the viscus.

Methods of Examining the Bladder.

When a patient presents himself complaining of increased frequency of micturition and other evidences suggestive of chronic disease of the bladder, a systematic examination of the individual and his urinary passages must always be instituted. The history of the case, the character of the symptoms, and the condition of the urine are carefully gone into. At the first interview it is advisable to ask the patient to void his urine, after which, providing no tight stricture exists, a medium-sized catheter-à-boule, or one of rubber, should be gently introduced, and the amount, if any, of the residual urine estimated and tested. Having gained all the information possible from this source, an examination of the bladder should then be made, or perhaps at a subsequent visit. (1) The patient is laid on a couch, and the lower part of the abdomen uncovered. The hypogastrium is then examined by inspection, palpation, and percussion, so as to ascertain whether or not the bladder is distended, or if any abnormal resistance either from thickening of the wall or the presence of a tumour can be felt. (2) A sound is then passed according to the method described at p. 1027, and the interior of the viscus explored; by this means a calculus may be detected, and even sometimes a tumour, as also a rough and irregular condition of the mucous membrane. (3) The finger is inserted into the rectum, or, in the female, into the vagina, before the sound is withdrawn, so as to enable the condition of the posterior vesical wall to be investigated between the point of the finger and the sound. Enlargement of the prostate or of the vesiculæ seminales can also be detected in this way. (4) As mentioned elsewhere, Bigelow's evacuator is useful, not only to wash out the bladder, but

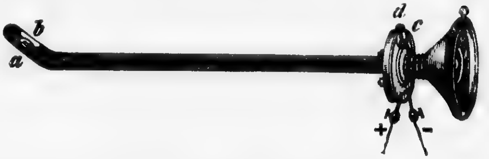


FIG. 337.—LEITER'S ELECTRIC CYSTOSCOPE. (TILLMANNS.)

a, Electric lamp in beak; *b*, glass window for illumination purposes; *c d*, switch for opening or closing current.

also to detect the presence of very small calculi which the sound may have missed. (5) Of recent years a new means of examining the interior of the bladder has been introduced in the shape of the *cystoscope* (Fig. 337). This consists of a straight tube with a short end bent at an angle, in which an electric lamp is placed, the wires leading to it being carried within the tube. A small window covered with glass is situated close to the angle, and a prism inserted at the angle in such a manner that, when the surgeon looks through an eyepiece placed at the end of the instrument, he is able to see the portion of the vesical wall illuminated by the electric lamp. To use it, the bladder must be previously washed out, and the patient anæsthetized. About six ounces of boric acid lotion should be present in the bladder, so as to prevent the vesical wall from being injured by the instrument, which always becomes hot after the lamp has been used for some time. Different ends are supplied to enable the anterior and posterior walls to be examined. Considerable practice is needed for any useful information to be gained by the aid of this instrument, but in skilled hands much may be learnt as to the condition of the mucous membrane. (6) Finally, in cases where great irritability of the bladder exists in spite of treatment, and no condition is found to explain its existence, an exploratory cystotomy is permissible either by the suprapubic or perineal methods.

Inflammation of the Bladder.

Acute Cystitis, or inflammation of the bladder wall, results from: (i.) Cold in gouty subjects; in fact, there are certain individuals who often 'take cold' in their bladders, instead of developing a bronchial or nasal catarrh. (ii.) It is sometimes due to traumatic causes, *e.g.*, the presence of foreign bodies, or injury to the viscus during operation. (iii.) It occurs most frequently as a complication of gonorrhœa, owing to an upward extension of the inflammation, and in such cases the symptoms are often very severe. (iv.) It may result from the absorption of irritating poisons, such as cantharides. (v.) Septic cystitis may supervene if a dirty instrument is introduced, and there can be but little doubt that this was a most prolific source of the mischief in times past; it is especially likely to occur when the bladder is paralyzed in cases of spinal injury. Under these circumstances infection may supervene even when sterilized instruments are employed, owing to the presence of mucus in the urethra, along which cocci are able to find their way. The importance of sterilizing the penis and guarding the external meatus by an antiseptic dressing in these cases has already been referred to (p. 505).

The **Bacteriology** of cystitis has not been very satisfactorily worked out, but that bacteria are present and play an important part in its production cannot for a moment be doubted. The *Bacillus coli* is one of the most common microbes found, and may be unaccompanied by other organisms, the urine remaining acid, though stale and objectionable to the smell. How it reaches the bladder is somewhat uncertain, but probably in girls—in whom this variety of cystitis is not unfrequent—it may reach the urinary organs by direct infection from the rectum to the vulva, a vulvo-vaginitis being sometimes associated with it. It has also been shown that any wound of the rectal mucosa is liable to be followed by migration of bacilli into neighbouring organs.

More commonly the urine is alkaline and ammoniacal; in such cases organisms which have the property of decomposing urea are found, such as the *Proteus Hauser*, the *Diplococcus ureæ liquefaciens*, etc., with or without the *Bacillus coli*.

The **Symptoms** of acute cystitis consist in pain referred to the perineum and hypogastrium, together with tenderness on pressure over the symphysis pubis. This is accompanied by extreme irritability of the bladder, frequent efforts of a painful and spasmodic nature being made to pass water (strangury); but little urine is voided at a time, for as soon as any amount has collected it is ejected forcibly. It generally contains blood and pus, soon becoming alkaline, and teeming with bacteria. Some amount of fever is usually noted, as also vomiting, whilst tenesmus may be induced as a result of the proximity of the rectum to the inflamed bladder. The usual termination of the case is in resolution, but sometimes chronic irritability may persist. In rare instances the inflammation is of such a virulent nature as to cause death. The urine in these cases is usually exceedingly foul, and the fatal issue is due to exhaustion, peritonitis, suppurative pyonephrosis, or even acute septic poisoning; occasionally the whole mucous lining of the viscus may slough. In some patients, however, when the inflammation is concentrated at the neck of the bladder, retention, distension, and atony may ensue.

Treatment.—The patient should be kept in a warm atmosphere, and preferably in bed, and hot fomentations applied to the lower part of the abdomen; hot hip-baths twice daily, maintained for some time, are very advantageous. The diet should be restricted to fluid, and the patient allowed to partake freely of barley-water and other bland liquids. Alkalies and henbane may be administered, and morphia and belladonna suppositories are useful to allay the pain and irritability. As a rule, no instrument should be passed during the acute stage, unless retention is present; but if the urine becomes very foul, the bladder may be gently washed out. In the worst cases salol (10 to 20 grains) and boric acid (15 to 20 grains), administered by mouth, may do some good.

Chronic Cystitis is much more common than the acute variety. The usual cause is some irritation of the walls of the viscus, as from calculi, tumours, foreign bodies, tubercular ulceration, or retention and decomposition of urine, especially if associated with obstruction to the outflow, as by a stricture or enlarged prostate. It may also follow acute cystitis, whilst impairment of the nervous mechanism, as in various forms of injury or disease of the spinal cord, may induce trophic changes and predispose to its occurrence.

The **Symptoms** are those of irritability of the bladder, the patient constantly desiring to pass water, and having to rise at night, perhaps several times, for this purpose. The urine becomes turbid, and on standing deposits a variable amount of mucus or muco-pus, mixed with epithelial cells, crystals of triple phosphate, and a granular sediment of phosphate of lime. It is usually alkaline, perhaps foul-smelling and ammoniacal, containing an abundance of micro-organisms. There is often but little pain, though when a calculus exists, or the neck of the bladder is ulcerated, it may become a prominent symptom. The patient's general health is not at first affected, but if the symptoms persist it soon becomes impaired, partly from the absorption of septic products from the bladder, and partly from the want of rest and sleep arising from nocturnal disturbance, and this may be so marked as to lead to fatal exhaustion. In other cases the inflammation may spread from the bladder along the ureters to the kidney, and the phenomena of septic pyonephrosis manifest themselves (p. 993).

Pathologically, the mucous membrane is thickened and congested, the superficial veins dilated and even varicose, whilst ulceration is not uncommon. The continued repetition of the acts of micturition leads to hypertrophy of the bladder wall, which becomes thickened and fasciculated; this effect is most marked when the cystitis is associated with obstruction to the outflow of urine. The mucous membrane may protrude outwards between the muscular fasciculi, giving rise to pouch-like saccules, in which phosphatic concretions are formed, and the retained urine undergoes decomposition. Perforative ulceration occasionally follows, originating a fatal peritonitis or pelvic cellulitis from extravasation of urine. The contracted state of the bladder and the overgrowth of its muscular substance lead to compression of the openings of the ureters, hydronephrosis being thus induced. A plug of viscid mucus often finds its way into the ureteral orifice, and by becoming infected with bacteria causes an extension of the septic mischief to the kidney.

The **Diagnosis** of chronic cystitis is readily made from the characteristic symptoms of irritation of the bladder and the condition of the urine; but considerable difficulty may be experienced in determining its cause. In investigating a case, not only must the history of its onset be considered, but also the general history of the patient, whilst a thorough examination of the lower urinary passages must be instituted, and the urine examined microscopically. The passage of a catheter or sound will generally detect any obstruction located in the urethra, whilst the bladder is also examined by the different methods described at p. 1006.

The **Treatment** of chronic cystitis is naturally directed towards its cause if such can be discovered; thus, calculi or foreign bodies should be removed, and strictures dilated. In most cases, even where the cause is not apparent, great benefit will be derived from washing out the bladder. Catheters and other instruments should always be sterilized or purified before use, and lubricated with some antiseptic preparation, such as carbolic oil (1 in 20); for it is all-important to remember that sepsis, if not already present, is readily induced, and that its presence renders the case much more difficult to cure.

The bladder is best irrigated by passing a soft rubber instrument, to the end of which is attached a portion of drainage-tube about 3 feet long, and beyond this a glass funnel, into which the material employed is poured. By raising the funnel the fluid runs into the bladder, whilst on depressing it below the bed or couch the fluid returns on the syphon principle. The patient's sensations must guide the surgeon as to how much fluid can be borne in any particular case. Various solutions are employed for this purpose, but perhaps the most useful are Condy's fluid, sanitas (1 in 10), boric acid (20 grains to 1 ounce), perchloride of mercury (1 in 2,000), or a neutral solution of quinine (2 grains to 1 ounce), and they may be used alternately with advantage. The frequency with which the injections are made must vary with the severity of the symptoms; it is not often necessary to perform the operation more than once or twice a day. At the same time that this local treatment is being adopted, the patient's general habits of life must be regulated. The diet should be bland and unstimulating; alcohol is better avoided, but if essential for other reasons, well-diluted gin or whisky may be given. Tea and coffee should be prohibited, whilst a milk diet is perhaps the best which can be employed. As to medicines, there are none which can alter the reaction of the urine from alkaline to acid, but perhaps salol, boric acid, or benzoic acid may be of some assistance. Hot infusions of buchu, uva ursi, and triticum repens, act as mild diuretics, and as alteratives to the vesical mucous membrane; full doses, however, such as a pint or a pint and a half in the course of the day, are needed. Where much muco-pus is excreted, copaiba, cubebs, turpentine, or sandal-wood oil may be advantageously exhibited, whilst injections of dilute astringents have been advised, but must be used with caution.

In cases which do not improve, and if the patient is becoming exhausted from the constant interference with his rest, etc., the only means of treatment left is that of opening the bladder through a perineal incision. *Perineal Cystotomy* is undertaken not only for the draining of a chronically inflamed bladder, but also to explore the mucous lining of the viscus, to remove growths and foreign bodies, as also sometimes to deal with prostatic enlargements and calculi. The bladder is first thoroughly washed out, a few ounces of antiseptic solution being left within it. After anæsthesia has been induced, a staff with a median groove is passed into the bladder, and then the patient is placed in the lithotomy position, and the perineum shaved. An incision is made in the middle line of the perineum, from a point 2½ inches in front of the anus to about 1 inch from that opening. The knife divides the deeper structures of the perineum, and, guided by the left index-finger in the wound, is made to enter the groove in the staff at a point corresponding to the membranous portion of the urethra. It is then carried upwards and backwards along the groove, incising the prostate and entering the bladder. The knife is carefully withdrawn, the finger gently inserted into the bladder, and the staff removed. After digital exploration of the bladder, a full-sized gum-elastic catheter (No. 16 or 18) is passed in through the wound and fixed, a long piece of rubber tubing being attached to allow of the constant escape of the urine, as well as to permit of occasional irrigation. The catheter is removed and changed at the end of forty-eight hours, and in favourable cases may be discontinued altogether at the end of a week, and the perineal wound allowed to heal; in severer cases a permanent opening may have to be maintained.

Tubercular Disease of the Bladder may be primary or secondary, the latter extending from similar disease in the kidney, prostate, or testicle. It is much more common in men than in women, and is most frequently seen in young adults. It commences in the submucous tissue as a deposit of miliary tubercle, which caseates and suppurates, breaking down, and giving rise to ulcers with undermined edges; they are rarely of large size, are usually multiple, and situated in or near the trigone. The **Symptoms** are those of chronic cystitis and hæmaturia, the irritability of the viscus being very marked. The diagnosis is made by demonstrating the bacillus of tubercle in the urine, and by the cystoscope. The course of the case is unfavourable, death resulting from general infection, tubercular phthisis, or extension to the kidneys.

Treatment.—The case is usually treated for some time as one of chronic cystitis before its nature as a tubercular affection is ascertained. In the milder cases it may suffice to attend to the general health and hygiene of the individual, and to wash out the bladder with some antiseptic two or three times a week, leaving a drachm or two of a 10 per cent. solution of iodoform in olive oil within the viscus. In more advanced cases cystotomy may be undertaken, preferably by the suprapubic method, and the ulcerated surfaces scraped and disinfected by applying the galvano-cautery or pure carbolic acid. To effect this the method suggested by Mr. Hurry Fenwick, of using a suitable speculum as a caisson through which to work, is especially to be recommended.

Very similar **Symptoms** may be induced by the presence of a **Simple Ulcer of the Bladder**, which, according to Fenwick, occurs not unfrequently. It is usually single, and situated near the neck or trigone, giving rise to great irritability of the viscus and hæmaturia, although the urine remains clear. The diagnosis is best made by the cystoscope. Phosphatic deposits sometimes form over the ulcerated surface, and may suggest the existence of a stone. The treatment now recommended consists in washing out the bladder with lactic acid (½ to 3 per cent.), or in scraping and cauterizing the base of the sore through a suprapubic incision.

Tumours of the Bladder.

New growths from the vesical wall are not very uncommon; they may be simple or malignant.

Simple Tumours occur in the form of fibroma and myxoma, but that most often seen is the **Papillomatous** or **Villous Tumour**, which shows itself as a soft flocculent mass, usually situated near the trigone, and close to the opening of one of the ureters (Fig. 338). The floating tufts or villous processes consist of an extremely delicate connective tissue, covered with a layer or two of epithelium similar to that lining the bladder, and traversed by bloodvessels. Occasionally the growths have a narrow base, and are pedunculated, but more frequently are sessile. They may be single, or may multiply rapidly, and spread all over the bladder by infection from the primary growth.

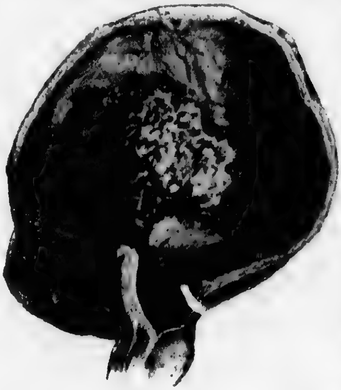


FIG. 338.—VILLOUS TUMOUR OF THE BLADDER. (FROM KING'S COLLEGE MUSEUM.)

The **Symptoms** are those of recurrent hæmorrhage, the blood being of a bright red colour, followed later on by irritability of the bladder. At first the hæmorrhage is intermittent, considerable intervals occurring between the attacks; but subsequently it becomes more continuous. The irritability of the bladder is generally induced by chronic cystitis, and when the urine has undergone alkaline changes, there is a copious exudation of ropy mucus which, mixing with the urine, causes considerable difficulty in micturition, leading in some cases to strangury. On standing, this deposit becomes so tenacious and jelly-like as to be poured with difficulty from one vessel to another. The urine may also contain portions of the tumour which have been set free, and occasionally, if situated near the neck of the bladder, some of the fimbriated ends may be swept into the urethral orifice, and interfere with micturition. In the same way the opening of one or both ureters may be encroached upon, leading to hydronephrosis. On examination of the bladder with a sound, nothing definite can be detected, unless the surface of the growth becomes encrusted with phosphates, and no abnormality is noticed on rectal examination. Occasionally a small portion of the growth may be caught in the eye of a catheter.

The **Prognosis** of the case is unsatisfactory, since, although the growth is not at first malignant, it often becomes so, and leads to a fatal termination through exhaustion, hæmorrhage, or septic complications.

Malignant Disease of the bladder may originate in that viscus, or may spread to it from the rectum or neighbouring organs. In the former case, a squamous epithelioma is the type usually met with, although sarcoma is occasionally seen; in the latter, the nature of the growth is, of course, similar to that of the primary disease; thus, when secondary to rectal cancer, the tumour is a columnar epithelioma. Most frequently the affection commences in the posterior wall above the trigone, extending forwards to the neck of the bladder. The growth is sometimes superficial, projecting into the vesical cavity as a soft spongy mass, which does not ulcerate early, or tend to invade the muscular walls till late; but more frequently the neoplasm extends into the walls, and infiltrates them, whilst marked ulceration is also present, the raw surface often becoming coated in places with a phosphatic deposit (Fig. 339). A cancerous growth in the bladder is always more or less likely to become papillated.

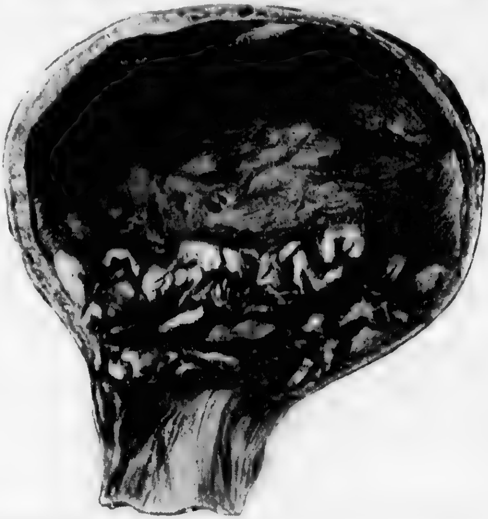


FIG. 339 CANCER OF BLADDER. (COLLEGE OF SURGEONS' MUSEUM.)

The **Symptoms** vary somewhat in these two forms, although the conspicuous features of each are hæmaturia and irritability of the bladder. In the slowly growing superficial variety, the tumour often attains a considerable size before causing any trouble, beyond possibly some slight irritability of the bladder. A severe attack of hæmaturia, unaccompanied by pain, is usually the first symptom of importance, and may be induced by some injury which causes a crack or fissure in the growth. This painless hæmaturia closely simulates the early symptoms of a simple villous tumour, but is more persistent, and yields less readily to treatment. After one or more of such prolonged attacks, cystitis usually follows, and the subsequent history resembles that of the harder and more rapidly growing infiltrating tumours. In such the symptoms of vesical irritability precede those of hæmaturia. Dysuria and severe pain referred to the bladder and perineum are complained of, and the urine early becomes alkaline and putrescent; shreds of the growth may also be found in the urine on microscopic examination. If the tumour involves the internal meatus, micturition may be considerably impaired, whilst if the orifices of the ureters are obstructed, hydronephrosis results. On passing a sound, the tumour can be detected as an irregular mass projecting into the bladder, whilst the posterior vesical wall may be felt *per rectum* to be hard and resistant; its ulcerated surface may also be seen with the cystoscope.

The course of the case is similar to that of a somewhat rapidly growing carcinoma, leading to early and marked cachexia, increased by the sleeplessness resulting from the vesical irritation; secondary deposits are found in the viscera and the lumbar glands, whilst occasionally perforation of the wall may follow, causing urinary extravasation, septic cellulitis, and death. Another most distressing complication is the establishment of a recto-vesical fistula, through which fæces make their way into the bladder, thus intensifying the sufferings of the patient.

The **Diagnosis** of a vesical tumour can only be made with certainty by the cystoscope, or by discovering fragments of its substance in the urine, though in the female it is easy to dilate the urethra, and explore the bladder with the finger. Whenever hæmorrhage is associated with marked vesical irritability, and cannot otherwise be explained, a tumour of the bladder may be suspected. The question as to whether or not it is malignant can only be determined by a careful examination of the symptoms. In simple papilloma, and the superficial type of epithelioma, hæmorrhage precedes the irritability; but whilst it is usually impossible to detect the villous growth either by examination with the sound or from the rectum, a fungating malignant growth may sometimes be recognised by the sound. In the infiltrating type of malignant disease, on the other hand, pain and dysuria always precede the bleeding for a considerable interval, whilst definite evidence of the existence of the growth can usually be made out, both by the sound and on rectal examination. A worn and exhausted appearance must not be looked on as necessarily the outcome of advanced cancerous cachexia, since the loss of rest and sleep due to chronic vesical irritability can of itself lead to a somewhat similar condition.

Treatment of Tumours of the Bladder.—In the early stages, when the diagnosis of a tumour has not been confirmed, the hæmaturia may be treated with ordinary hæmostatic remedies, such as a mixture containing dilute sulphuric acid and ergot, or turpentine administered in capsules (10 minims three times a day). When once a diagnosis has been established, removal by operation is the only plan which holds out any hope to the patient, and such can only be undertaken with any prospect of success in benign growths, or in the very earliest stages of the superficial form of malignant disease. The bladder is laid open either by perineal or suprapubic cystotomy, and the growth removed either by scraping or curetting. The suprapubic operation is certainly preferable, in that it gives one the opportunity of definitely seeing the interior of the bladder. The plan already mentioned of employing an expanding speculum as a caisson will be found useful; when all moisture has been sponged away or sucked up, the vesical wall is seen at the bottom of this tube by means of an electric lamp fitted to the surgeon's head. In default of a better instrument, a Fergusson's speculum might be utilised. Growths may be removed by means of long-handled instruments specially adapted for the purpose, and the base from which they spring must be carefully cauterized.

Where removal is impracticable, it only remains to ease the patient's sufferings by means of morphia, the bladder also being occasionally washed out; but where the irritability is very great, a permanent suprapubic or perineal opening may be established.

Functional Derangements of the Bladder.

Incontinence of Urine.—A patient is said to be suffering from incontinence when the urine escapes involuntarily, dribbling away either constantly or intermittently from the urethra.

1. **Active Incontinence** is often present in young children, mostly boys. It results from some condition of increased excitability of the urinary apparatus, and is looked on by some as of a choreic nature; in other instances, it is probably due to weakness of the sphincter vesicæ, which is unable to resist the pressure induced by even a small amount of urine. The chief sources of irritation are phimosis, ascarides in the rectum, a rectal polypus, or urine of high specific gravity, containing uric acid crystals in suspension. The affection is most obvious at night, and, indeed, may only occur during sleep; it has been known to persist till adult

life is reached. Somewhat similar in nature to this is the irritability of the bladder induced by calculus, inflammation, or ulceration, where frequent calls to micturition are experienced; to this, however, the term 'irritability of the bladder' is applied, 'incontinence' being only used where no active disease of the viscus is present.

Treatment of the nocturnal incontinence consists in the removal of all sources of irritation, such as a tight foreskin, whilst the child is waked from sleep at regular intervals in order to pass water, so as to break him of the bad habit. Tonics, such as iron, arsenic, and quinine, may be administered, and tincture of belladonna in full doses should also be given. Instruments have been used for compressing the urethra at night, and are said in some cases to have effected a cure.

2. **Passive Incontinence** is said to be present when the neck of the bladder is relaxed, so that as soon as any urine is secreted, it flows out of the urethra, the bladder in this way never becoming distended. It arises mainly from two causes: (*a*) *Paralysis* of the sphincter vesicæ, as a result of some injury or disease of the spinal cord, which may either temporarily or permanently impair its function. Thus, in severe shock the urine is unconsciously evacuated from relaxation of the sphincter; but if the lumbar cord is not compressed or destroyed, the function is soon regained. Any lesion involving the centre for the sphincter necessarily destroys its future utility, and results in permanent incontinence. It is quite possible for the detrusor centre to be damaged without injury to the sphincter, and in such a case distension of the bladder with subsequent overflow supervenes. Paralytic incontinence occasionally follows overdistension of the female urethra for the removal of a calculus. Nothing can be done for either of these conditions, if permanent, beyond the application of a suitable urinal. (*b*) *Mechanical Incontinence* may sometimes be brought about by the internal orifice of the urethra being wedged open, as by the impaction of a calculus, or the existence of a pedunculated growth from the prostate.

3. **False Incontinence**, or **Distension with Overflow**, results from any condition in which the outflow of urine is impeded to such an extent as to lead to a certain quantity being left in the bladder after every act of micturition, although the patient imagines that the organ has been completely emptied. This so-called *residual urine* gradually increases in amount until the bladder becomes filled, and some of it dribbles away involuntarily so as to wet the patient's clothes. In well-marked and old-standing cases the bladder can be detected as a tense, rounded swelling in the hypogastrium. This condition is usually met with in patients with neglected stricture or enlargement of the prostate, and in the latter case the bladder may be so distended as to contain several pints of urine. Very much the same state of things obtains in paralysis

due to spinal mischief (p. 514). Treatment must be directed to keeping the bladder emptied by the regular use of the catheter, but it often remains in an atonic state for some time.

Atony of the Bladder is the term given to a condition in which the patient is unable to expel its contents, not in consequence of any true paralysis of the muscular walls, but simply from loss of tone. The most usual causes are: (1) Chronic overdistension, the result of obstruction to the outflow, owing to enlarged prostate or stricture, as just described. (2) A single prolonged voluntary or involuntary overdistension; for instance, owing to the oversight of a house-surgeon, a patient suffering from retention after an operation for varicocele was left unrelieved for more than twenty-four hours, whereby atony was induced. (3) It occasionally follows cystitis, especially that associated with gonorrhœa. (4) In old age atony is occasionally due to simple loss of nerve tone, a condition very similar to that which occurs after or in the course of infective fevers, such as typhus, and is even met with after influenza.

In the slighter cases all that is noticed is some hesitation or difficulty in commencing the act of micturition, whilst the flow of urine is weak, and cannot be efficiently completed, a few drops dribbling away afterwards. In worse cases a considerable amount of residual urine may be left in the bladder, and this may lead to chronic distension with overflow, and by its decomposition to chronic cystitis. In other cases actual retention may be induced. The **Treatment** should be directed to removing any source of obstruction which exists, whilst regular catheterism two or three times a day will prevent any distension of the bladder, and the administration of strychnine, phosphoric acid, and other tonics, will improve the expulsive power of the viscus. The passage of a constant current of electricity may also be employed two or three times a week, to stimulate the muscular fibres; one electrode is inserted into the bladder, and the other placed over the hypogastrium.

Retention of Urine.—When a person is unable to expel the contents of the bladder, so that it becomes distended, retention is said to be present. It results from a variety of conditions, classified as follows: (1) *Penile and urethral* causes, *e.g.*, phimosis, or congenital occlusion of the urethra, a ligature or ring placed around the penis, impacted calculus, the so-called congestive or spasmodic stricture, organic stricture, urethral or perineal abscess, ruptured urethra, etc: (2) *Prostatic* causes, *e.g.*, inflammation, abscess, tumour, hypertrophy, calculus: (3) *Vesical* causes, *e.g.*, atony, paralysis, calculus, tumours, etc: (4) *Reflex* irritation, such as occurs after operations on the rectum and anus, or involving the spermatic cord: (5) *Hysteria*: (6) *Pressure* from neighbouring organs or external tumours, *e.g.*, uterine fibroids, or retroversion of the gravid uterus. In investigating any particular case, the age and condition of the patient must be taken into consideration, and also the character of any preceding urinary symptoms, whilst a careful examination should be made. Speaking generally, one may state that the most common cause of retention in infants is phimosis; in children, impacted calculus, or a ligature around the penis; in young men, gonorrhœa or one of its complications; in young women, hysteria, or foreign bodies in the bladder; in adult men, stricture; in adult women, some uterine condition; and, in old men, hypertrophy of the prostate.

If left unrelieved the urine accumulates, and the bladder becomes distended, giving rise to much pain and discomfort. One of two conditions is certain to follow: (*a*) In cases of retention from stricture the dilated urethra behind the seat of obstruction gives way, resulting in extravasation of urine. If, however, the bladder wall is weakened by the presence of sacculation, rupture of a saccule may follow, causing pelvic extravasation. (*b*) When the retention arises from atony or paralysis, or from some obstruction which can be to some extent overcome, distension with overflow is produced.

Inasmuch as retention is merely a symptom, the **treatment** necessarily varies with the cause.

Abnormal Conditions of the Urine.

1. **Urinary Deposits.**—*Uric* or *lithic acid* is eliminated in the form of 'cayenne-pepper' granules, usually known as gravel. On microscopic examination, the granules are found to consist of flat rhomboidal, lozenge-shaped plates, or masses of acicular crystals (Fig. 340). They are of a dusky brownish-red colour, due to the absorption of urobilin, the normal pigment of the urine. The secretion in these cases is always acid, and usually of high specific gravity. The deposit is not soluble in boiling water, but readily so in alkaline fluids; and on reacidulating such a solution, the uric acid is precipitated in the shape of white needle-shaped crystals.

Urates or *lithates* of potassium, sodium, or ammonium are of frequent occurrence in the urine, being met with in the form of a deposit of amorphous granules of variable colour, according to the amount of urinary pigment present, and this is often known as a 'lateritious,' or brick-dust sediment. The ammonium salt is sometimes found in the shape of spiculated globular bodies (Fig. 341). Urates always occur in acid urine of high specific gravity, and are freely soluble in boiling water; on the addition of dilute hydrochloric acid the uric acid is precipitated. The *murexide* test may be applied either for uric acid or its salts; it consists in mixing the substance to be tested with a little nitric acid, and evaporating to dryness, when an orange-red discoloration is produced, which on the addition of liquor ammoniæ changes to a deep purple-red.

A deposit of uric acid or urates is either a temporary condition dependent on some trivial derangement of the system, or is a phenomenon constantly recurring and due to too great an indulgence in nitrogenous food, too little fresh air and exercise, or imperfect digestion, the result of some hepatic derangement. It is also noted in conditions where great tissue change is occurring, as after violent exercise or in fevers. Under these circumstances the materials which should be changed into urea are transformed into uric acid or its salts. When such a tendency is continually present, the patient is often said to be suffering from **Lithiasis** or **Lithæmia.** Should the individual be incapable of eliminating the material thus formed, an attack of gout or rheumatism is likely to supervene, whilst it must always be borne in mind that the formation of a uric acid calculus is merely a manifestation of the same diathesis, which needs careful treatment after the removal of the stone, if a recurrence of this painful affection is to be prevented.

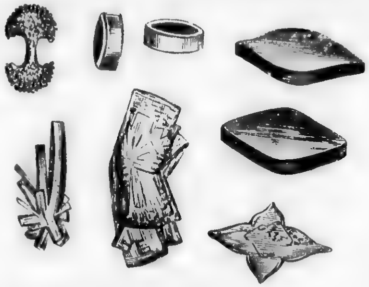


FIG. 340.—URIC ACID CRYSTALS

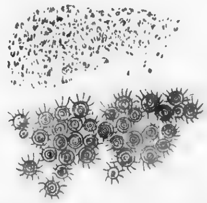


FIG. 341.—URATE OF AMMONIUM IN AMORPHOUS GRANULES AND HEDGEHOG-SHAPED BODIES.

The **Treatment** of lithæmia or lithiasis consists mainly in attention to personal hygiene. The patient's diet must be regulated, all sweets, pastry, and alcoholic stimulants (with the exception, perhaps, of a little whisky well diluted with lithia or potash water) being avoided. Regular habits must be followed, and plenty of outdoor exercise indulged in. The hepatic secretion must also be stimulated, and the bowels regulated by the administration of saline purgatives, especially natural mineral waters, *e.g.*, Friedrichshall, Carlsbad, or Hunyadi Janos, whilst an occasional dose of blue pill or podophyllin is also advisable. Lithia salts and piperazine have also been recommended and employed with advantage.

Oxalate of lime usually occurs in the urine of dyspeptic and hypochondriacal patients, who are pale, nervous, and irritable.

It is supposed to arise from the incomplete oxidation of carbohydrate foods. The urine is of low specific gravity, pale and abundant in quantity, and slightly acid in reaction; an excess of mucus is usually present, causing the crystals to adhere to any irregularities in a test glass. On microscopic examination they are found to be regular octahedra, or in the shape of dumb-bells (Fig. 342). The treatment of oxaluria consists in regulation of the diet, which must be light and nourishing, all heavy food being avoided, as also rhubarb, which contains large quantities of oxalates, and the patient is directed to drink only boiled or distilled water. Tonics, such as mineral acids, iron, and quinine, may be ordered, but the best treatment consists in change of air, and removal, if possible, from causes of worry and anxiety.

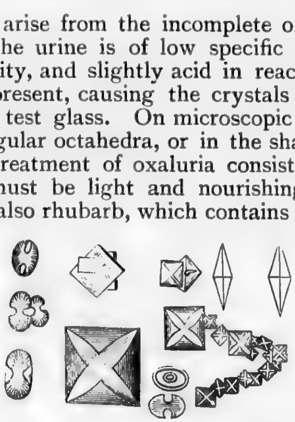


FIG. 342.—OXALATE OF LIME IN OCTAHEDRAL CRYSTALS AND DUMB-BELL-SHAPED MASSES.

Phosphatic deposits in the urine occur in three forms: (i.) The triple phosphate, or ammonio-magnesic, is found in alkaline or decomposing urine, and is always vesical in origin. It exists in the form of hexagonal prisms, three of the sides, however, being very narrow; the ends also are bevelled off, so that the appearance of a 'knife-rest' is produced (Fig. 343). (ii.) The amorphous phosphate of lime is exceedingly common, forming the main mass of any phosphatic sediment. It is always present in chronic cystitis, and is not unfrequently met with a few hours after a meal, constituting what is known as the 'alkaline tide.' This condition is often observed about twelve o'clock in the morning, especially if an alkaline saline purgative has been taken before breakfast. The phosphatic material is voided at the end of the act of micturition, and may give rise to considerable anxiety on

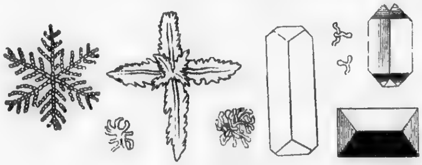


FIG. 343.—CRYSTALS OF TRIPLE PHOSPHATE IN URINE.

the part of the patient, who may mistake it for seminal fluid. (iii.) The most usual condition in which phosphates are met with in urine is a mixture of the two varieties described above. Whichever form is present, the deposit becomes more evident on boiling, disappearing, however, on the addition of a few drops of acid. The treatment of phosphaturia is always directed to the vesical condition, except in those unusual cases where it is due to some constitutional error.

2. **Hæmaturia**, or the admixture of blood with the urine, is best described according to the source from which the blood comes.

(*a*) *Renal* hæmaturia results from acute inflammation, congestion, calculus, tumours, or injuries of the kidney. The urine is usually deeply coloured with the blood, and may be as dark as porter. Blood casts of the renal tubules are often observed, and even long sinuous clots, corresponding to the shape of the ureter.

(*b*) *Vesical* hæmaturia is due to injury, calculus, tumours, ulceration, simple congestion of the bladder, with varicosity of the vesical veins, or the presence of the *Bilharzia hæmatobia*. The blood is always intimately mixed with the urine, but is more abundant at the end of micturition, and clots are not unfrequently present.

The *Bilharzia* is a parasite which inhabits some of the rivers and pools of South Africa. It is taken into the system by the mouth, and may develop either in the urinary track, or sometimes in the lower bowel (p. 959). The adult worms are found in the body inhabiting the radicals of the portal and vesical veins, and discharge their ova through the mucous membrane of the bowel or bladder, giving rise to hæmorrhage. By an extension to the kidney, pyonephrosis may be induced. No specific treatment has at present been discovered, but in most cases the disease tends to disappear spontaneously.

(*c*) *Prostatic* hæmaturia may be caused by congestion, calculus, ulceration, or malignant disease; the blood passes back into the bladder, and hence the phenomena simulate the vesical condition. Examination of the prostate from the rectum may, however, give a clue to the source of the mischief.

(*d*) *Urethral* hæmaturia arises from acute gonorrhœa, laceration, or instrumentation. The blood often flows from the urethra independently of micturition, whilst the first few drops of the stream are also coloured.

(*e*) Hæmaturia is occasionally of *constitutional* origin, arising from purpura, scurvy, or hæmophilia; other evidences of these diseases will be observed, and render the diagnosis evident.

Microscopical examination of the urine should always be made to ascertain whether or not blood corpuscles are present, since the condition may be simulated by that known as 'paroxysmal hæmoglobinuria,' in which corpuscles are absent. The latter condition is supposed to be due to vaso-motor spasm of the renal vessels, and is not uncommonly associated with Raynaud's disease.

The only sure test for the presence of blood is by spectrum analysis; but that most usually relied on consists in mixing together equal parts of tincture of guaiacum and rectified spirit of turpentine. The suspected urine is subsequently added, and sinks to the bottom of the test-glass; a copious precipitate forms at the line of junction of the two fluids, which on standing becomes a bright blue colour if blood is present.

The investigation of a case of hæmaturia in order to ascertain its origin should be conducted in the following way: (*a*) The history of the patient and of his urinary trouble should be taken. (*b*) The character of the urine should be investigated, noting its colour, and whether the blood is intimately mixed with it or not. (*c*) The relation of the passage of the blood to the act of micturition should be noted by making the patient pass the first and last portions of the urine into separate vessels from that in which he passes the bulk; if the urine in all three vessels is equally discoloured, the hæmorrhage usually comes from the kidneys; if most of the blood is in the first vessel, it comes from the urethra or prostate, whilst if the bulk of it is contained in the last vessel, it is probably derived from the bladder. (*d*) Microscopical examination of the urine may lead to the discovery of shreds of tumour, epithelial cells, or blood-casts, which could be alone derived from some special part of the urinary track. By these means the source of the hæmorrhage, whether from kidney, bladder, prostate, or urethra, may be detected, and an opinion formed as to the nature of the disease.

3. **Pyuria** is the term applied to the admixture of pus or muco-pus with the urine. It always results from inflammatory affections of the mucous membrane lining the urinary passages, and may be renal, vesical, prostatic, or urethral in origin; the methods of investigation, in order to ascertain its exact source, are the same as for hæmaturia.

Pus in urine is mainly recognised by the microscope, whilst on the addition of liquor potassæ it becomes ropy.

4. **Chyluria** arises from distension or rupture of the lymphatic vessels in the vesical mucous membrane, and is usually due to the presence of the *Filaria sanguinis hominis* (p. 308). The urine is milky in colour, and on microscopical examination this is found to be due to the presence of an emulsion of fat.

5. **Albuminuria**, or the escape of some of the albuminous contents of the blood with the urine, is a condition of such frequent occurrence, and so important in its results, that the precaution should always be adopted of testing the urine of every patient before attempting any operative proceedings; and this is

the more essential because it is well known that this condition often exists quite unexpectedly and entirely apart from symptoms.

Tests.—Many different methods have been adopted for detecting the presence of albuminuria. The following are, however, the chief: (1) On simply boiling the urine a milky white deposit forms, similar to that which is caused by an excess of phosphates; the latter, however, disappears entirely on the addition of a single drop of dilute acetic acid, whilst the former persists. (2) Nitric acid gives a white cloud or light-brown flocculent precipitate. The urine should first be boiled, and the acid added, but not in excess, as the deposit may be re-dissolved. A more delicate test consists in pouring the cold urine into a test-tube, and carefully adding the acid, so as to form a stratum below the urine; at the line of junction of the two, a white film is formed, if albumin is present. (3) With picric acid a yellowish-white precipitate is thrown down, increased by boiling. If the urine is neutral or alkaline, it must first be rendered slightly acid by the addition of a few drops of acetic acid.

When once the existence of albumin in the urine has been ascertained, its source and its significance must be investigated. A careful microscopical examination of the sediment is made, so as to determine whether casts or pus cells are present. The condition of the peripheral bloodvessels in the limbs and the character of the pulse should be noted, as also the previous history of the patient.

Albuminuria arises from a variety of sources, and its significance necessarily turns on the origin of the affection. (1) When it occurs in the course of some disease involving long-standing suppuration, such as septic affections of bones or joints, it is probably due to lardaceous change in the kidneys. If the urine is of low specific gravity and light in colour, and with but few casts, only an early stage of the condition is present, and conservative measures directed to the treatment of the primary lesion will probably suffice; if, however, the urine is scanty and of high specific gravity with much albumin and many casts, the affection has probably progressed some way, and radical treatment, such as amputation, should be undertaken to save the patient's life. The surgeon must be careful to prevent any undue absorption of carbolic acid in the operation, as thereby acute nephritis may be lighted up, and even a fatal issue determined. (2) Albuminuria may be intermittent, and is then due to some temporary functional disturbance; this can only be ascertained by testing the urine from time to time. In such cases operation is not contra-indicated, the albumin usually disappearing with rest and careful diet. (3) When caused by chronic Bright's disease, the concurrent phenomena of that affection will also be present in the shape of thickened arteries and high pulse tension, whilst possibly a certain amount of anasarca may be noted, or the history of such at an earlier date. If there is but little albumin, and a fair amount of urea is being passed, it is possible by rest and suitable diet so to diminish it as to warrant the performance of slight operations; but where the condition is at all advanced, all *opérations de complaisance* are absolutely contra-indicated, and only the chief surgical emergencies should be knowingly dealt with, viz., hæmorrhage, asphyxia, intestinal obstruction or strangulation, and retention of urine. In cases of severe injuries, amputation is generally indicated under circumstances where in a healthy individual conservative measures would be adopted. The importance of not operating on these patients depends on the facts that they tolerate an anæsthetic badly, that the tissues are in a condition of lowered vitality, and hence the process of repair is hindered, septic inflammations and erysipelas are very prone to develop, whilst secondary hæmorrhage is likely to follow, owing to the high pulse tension. Again, boils and carbuncles are very common in these patients, and where such conditions are met with, and especially if they recur, the urine should always be examined. (4) Albuminuria may arise by extension of inflammation to the kidneys from surgical affections of the lower urinary organs, and a fatal result from shock or suppression of urine may be induced by operations under these conditions. (5) It is occasionally the result of cardiac disease, owing to valvular incompetence and regurgitation into the systemic veins, and then it is advisable to delay all operative measures until digitalis has been administered in sufficient doses to alleviate the urgent symptoms.

6. **Diabetes.**—The presence of sugar in the urine is also a matter of the greatest importance from a surgical standpoint, and its existence or not should always be carefully ascertained. The chief tests employed are as follows: (1) Equal parts of liquor potassæ and solution of copper sulphate are boiled together, and then a few drops of the suspected urine added; if sugar is present, a yellowish-red precipitate forms by the reduction of the cupric salt to cupric oxide. (2) The same result follows the use of Fehling's solution. It is better to keep the copper solution separate from the potash; equal parts of them are boiled together, and a few drops of the urine added; if sugar is present, a red deposit occurs. (3) Picric acid and liquor potassæ are mixed and boiled, and the urine added; the presence of sugar is indicated by the solution turning to a dark, blackish-red colour. The admixture of 2 grains of sugar to the ounce is sufficient to determine this discoloration to such an extent as to render the fluid quite opaque.

The effect of diabetes is very similar to that of albuminuria, in that it leads to diminished vitality of the tissues, and consequently to defective union of wounds, whilst it also predisposes to the occurrence of sepsis, and of such infective inflammations as boils and carbuncles. Peripheral neuritis and sclerosis of the smaller vessels are also induced by this disease, and hence gangrene of the extremities is likely to occur, especially in chronic cases and in elderly people. Operative proceedings should not be undertaken in these patients, except in conditions of emergency, since the shock of an operation is likely to lead to the occurrence of diabetic coma, which is usually fatal.

Stone in the Bladder.

Varieties.—A vesical calculus may be formed of almost any of the urinary deposits commonly met with, and each has its own special characteristics.

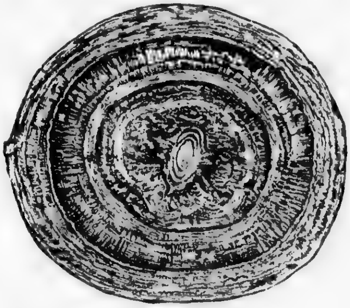


FIG. 344.—URIC ACID CALCULUS IN SECTION.

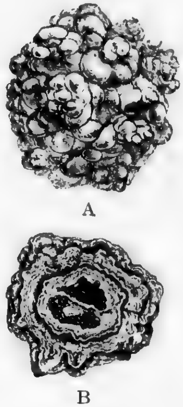


FIG. 345.—OXALATE OF LIME CALCULUS FROM OUTSIDE AND ON SECTION.

(*a*) The *uric acid* calculus is usually an oval, flattened body of considerable density, with a smooth or slightly nodular surface, and of a nut-brown colour. On section it is distinctly laminated, and it may be surrounded by a crust of phosphatic deposi (Fig. 344).

(*b*) The *urate of ammonium* calculus is of very similar structure, but of a lighter colour, and the lamination is less distinct.

(*c*) The *oxalate of lime* or mulberry calculus (Fig. 345, A and B) is a rough, irregular body, sometimes evenly nodular, but not unfrequently tuberculated, or even spiculated. It is extremely hard and dense, laminated, and of a dark red-brown colour, or sometimes black, owing to admixture with blood. It is rarely of great size, on account of the irritation caused by its presence, and its slowness of growth.

(*d*) A pure *phosphatic* calculus is exceedingly uncommon, but any stone or foreign body is certain to become coated with a phosphatic deposit when chronic cystitis with alkaline decomposition of the urine is present. Occasionally concretions of a similar nature form spontaneously in saccules of the bladder; such bodies are white and chalky in appearance, friable in consistency, with no evidence, or but little, of lamination, and on removal are exceedingly offensive. These concretions consist of a mixture of the triple phosphate and phosphate of lime. Less commonly an excess of the triple phosphate is present; if in the proportion of two parts of the latter to one of phosphate of lime, a laminated and somewhat denser calculus is produced, which is sometimes termed a *fusible calculus*, owing to the fact that it fuses to a bead under the blowpipe flame. Occasionally a phosphate of lime calculus occurs in the upper urinary passages, *e.g.*, the pelvis of the kidney, and has a crystalline appearance on drying.

(*e*) *Cystine* forms the basis of a rare calculus which is of a yellowish-green colour and waxy appearance.

(*f*) *Xanthine*, or xanthic oxide, occurs very exceptionally as a calculus of a reddish colour.

Structure of a Calculus.—A calculus usually consists of the following parts: 1. The *nucleus*, which may be formed by a portion of blood-clot, inspissated mucus, a renal calculus, or a foreign body. 2. The *body*, which consists of superposed layers of uric acid or oxalate of lime, or of whatever substance the stone is composed; not unfrequently the composition of adjacent laminæ differs, leading to what is known as an *alternating calculus*. Each lamina consists of myriads of minute crystals, held together by vesical mucus. A certain amount of phosphatic material is often mixed with the other matter, or layers of pure phosphatic deposit may be interposed. 3. The *crust* consists of a variable amount of soft, friable phosphatic material, the quantity of which is the measure of the degree of chronic cystitis originated by the calculus; in some cases it is entirely absent.

The **Number** of calculi present in a bladder varies greatly. Sometimes there is only one, but a considerable number, counted perhaps by hundreds, may exist; in such circumstances they are never of great size. Multiple calculi are not unfrequently faceted as a result of mutual friction.

The **Causes** of vesical calculus must be looked for in some of those constitutional conditions already described as predisposing to lithiasis or oxaluria. They are very common in children during the first decade of life, especially amongst the lower classes, the children of the rich rarely suffering from stone. It diminishes in frequency from childhood to the age of twenty-five, and then gradually increases until it is fairly common in elderly men. The condition is comparatively rare in women, owing to the fact that the shortness and large size of the urethra allow small calculi to be much more readily passed. Possibly the character of the drinking water, or the amount imbibed, is a matter of considerable importance, as indicated by the fact that the occurrence of calculus is very unequally distributed in different parts of the country; thus, it is most frequently met with in the Eastern counties. It is also exceedingly common in India and Arabia, a fact which may be explained by the large amount of fluid withdrawn from the body by perspiration.

Symptoms.—The effects produced by vesical calculi vary in different individuals, as a result partly of the shape of the stone, and partly of the tolerance of the mucous membrane. Thus, in children and young adults, where the parts are very sensitive, even a smooth calculus gives rise to severe symptoms, whilst old men often tolerate a large stone without much inconvenience; *cæteris paribus*, an oxalate of lime calculus is always more irritating than one composed of uric acid. The classical symptoms of a vesical calculus may be preceded by a history of the patient having passed 'gravel' for a long time, on the cessation of which the calculous symptoms commenced. They consist of pain in the perineum and neck of the bladder, which radiates to the back and down the thighs, but is especially noticed at the end of the penis immediately after micturition. The stone is then pressed down against the sensitive neck of the bladder by the contraction of its muscular walls. Increased frequency of micturition is also present, and perhaps hæmaturia of a vesical type, though this is not a prominent feature. All these phenomena are increased in severity by jolting, jumping, or any form of exercise, and hence are more marked during the day than at night. Occasionally the patient may complain that the flow of urine suddenly ceases before the bladder has been completely emptied, and that some change of position of the body is needed in order to allow him to complete the act. In addition to these characteristic symptoms, he may suffer from various phenomena secondary to the irritability of the bladder, and depending on the straining induced by the calculus. Thus, tenesmus, followed by piles or prolapsus ani, may be induced from sympathetic irritability of the rectum, especially in children; whilst a hernia may also be caused, and not unfrequently priapism.

The symptoms become somewhat modified in *children*, leading to irritability of the bladder, as evidenced by wetting of their clothes and of their beds at night, and pulling at the prepuce and penis. These manifestations are simulated by those produced by a tight foreskin, with which condition, indeed, it is often associated; hence, it is important always to sound the bladder of a child after circumcision for phimosis.

The actual **Diagnosis** of vesical calculus can only be made by *sounding*. In order to accomplish this, the patient is laid on a couch with the head low, and the buttocks raised on a pillow placed beneath them. The bladder should always contain a few

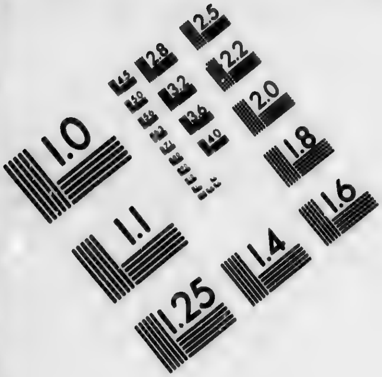
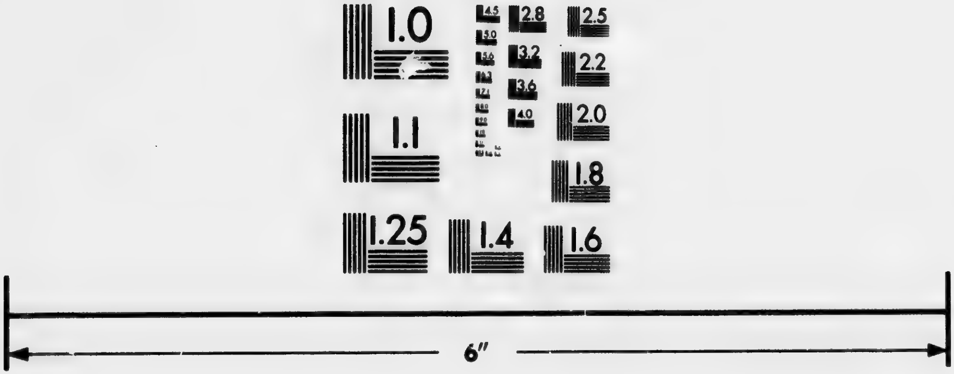
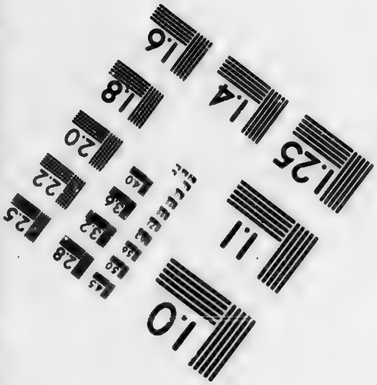
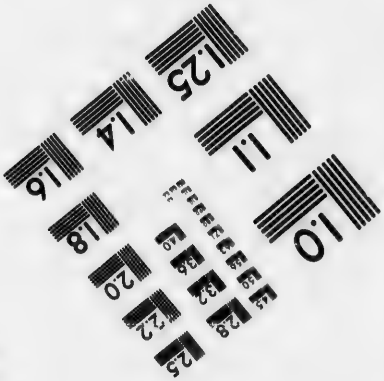


IMAGE EVALUATION
TEST TARGET (MT-3)







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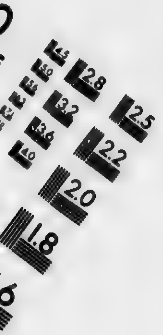
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ounces of fluid, so as to obliterate any folds produced by laxity of the mucous membrane, as well as to facilitate the introduction of the instrument. A sound of suitable size, warmed and lubricated by some antiseptic oil or ointment, is then gently passed along the urethra, and depressed between the separated legs so as to enable it to enter the bladder. The handle of the instrument, which should be cylindrical in shape and fluted, with the maker's name or some mark to indicate the direction of the beak, is then lightly grasped between the index-finger and thumb, and rotated from side to side at the same time as the whole instrument is drawn forwards or backwards in the urethra. Each side of the bladder is thus carefully investigated, whilst if no stone is detected, the beak is finally turned directly downwards, so as to examine the pouch which often forms behind a slightly enlarged prostate. The presence of a stone is recognised by a metallic click, which can be felt, and even heard, when the end of the instrument taps it. The character of the click is some guide to the size and density of the stone. The presence of two or more calculi is indicated by the surgeon being able to touch them on rotating the instrument alternately to each side of the middle line, or by seizing one stone with a lithotrite, and using it as a sound for the other. In doubtful cases, a still more delicate test than the sound is obtained by passing a medium-sized tube of a Bigelow's evacuator, and washing out the bladder. The calculi may by this means be washed out even from sacculi, and be felt to rattle against the end of the instrument when the pressure upon the indiarubber bulb is relaxed. When the calculi are multiple and of small size, they may be even removed in this way by an examination which was only intended to be diagnostic in character. The surgeon must not forget that a hypertrophied bladder with projecting fasciculi may somewhat resemble a calculus, especially when coated with phosphatic material. In some rare instances, a calculus may be so completely hidden in one of the saccules as to render its detection impossible by these means.

Course of the Case.—A patient suffering from vesical calculus is certain, sooner or later, to develop symptoms of chronic cystitis, and septic changes in the urine are equally likely to follow—possibly as a natural sequence, but more probably as the result of the introduction of septic instruments. The bladder becomes hypertrophied, and if the stone is not removed, the mucous membrane may become ulcerated, and surgical kidney almost invariably ensues; the patient's life is thus destroyed partly by exhaustion, and partly by septic poisoning. Occasionally a calculus becomes encysted in the saccule of a dilated bladder; it increases in size only on that part of the stone which is exposed at the mouth of the saccule, and hence may become more or less mushroom-shaped. It may be recognised by the sound always striking it in the same situation.

The **Treatment** of vesical calculus is a matter which has exercised the judgment and manipulative dexterity of surgeons for many generations. A large number of operations have been made use of, but at the present day only three are employed, viz., lithotrity, lateral lithotomy, and suprapubic cystotomy.

Lithotrity was formerly conducted at several sittings, the stone being crushed, and the patient allowed to pass the débris subsequently; this process was repeated at intervals of a few days, until the bladder was clear. Such a proceeding took a considerable time, and was exceedingly painful, irksome, and dangerous to the patient. The introduction of Bigelow's evacuator completely revolutionized this operation, and enables it to be completed at one sitting, constituting the proceeding sometimes termed Litholapaxy.

Operation.—The patient is carefully prepared by keeping him under observation for a few days, regulating the bowels, and, if possible, reducing any inflammation of the bladder by suitable diet and drugs, and by washing it out. On the preceding night a dose of castor-oil is administered, and an efficient enema a few hours before the operation. The patient should be warmly clad, and preferably the legs enclosed in thick worsted stockings reaching nearly to the groins. After anæsthesia has been induced, the head should be kept low, and a pillow placed beneath the buttocks, so as to slightly raise the pelvis. The bladder is carefully washed out with some bland antiseptic, such as a solution of boric acid, and about 6 ounces of lotion left within it, in order not only to obliterate all folds of mucous membrane, but also to facilitate the seizure of the stone, and to prevent injury of the walls during the operation.

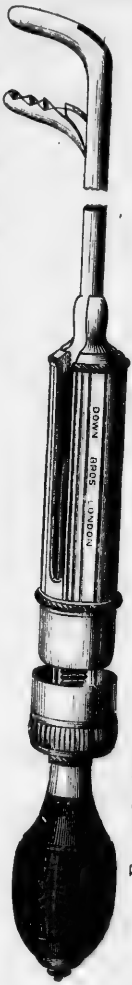


Fig. 346.—Thompson's Modification of Civiale's Lithotrite. (Down Brothers.)

The lithotrite is then introduced. The best instrument to employ is Thompson's modification of Civiale's (Fig. 346), the male blade of which is solid, and the female fenestrated. Other forms are sometimes used in which the female blade is solid, and is either the same size or larger than the male, in order to protect the walls of the bladder from injury. The male blade slides easily up and down a groove in the stem of the female blade, and after the stone has been seized, the blades are forcibly pressed together by a screw action, brought into play by the mechanism in the handle, which can be put in and out of gear at will. It is absolutely essential that the instrument should be made of well-tempered steel, so as to prevent any risk of breaking during the operation. To introduce it some skill is needed, since the curved end is short, and consequently the handle must be well depressed between the legs, in order that the beak may pass under the pubic arch. The position of the stone is next ascertained by rotating the instrument; the blades are opened, and the stone caused to roll between them by a slight jerk of the handle. This is better than attempting to pick up the calculus by inverting the blades, and is less likely to injure the mucous membrane. If fairly grasped, the blades when screwed up will crush it into several fragments, each of which is subsequently dealt with in a similar fashion. If only the margin of the stone is gripped, the application of screw pressure may cause it to slip away, and the manœuvre must then be carefully repeated. When the surgeon is satisfied that the fragments are sufficiently small, the largest evacuator-tube that can be safely introduced is passed into the bladder. To effect this, it is sometimes necessary to incise the urethral orifice with a bistoury in a downward direction. The evacuator is attached to the tube, and the bladder thoroughly washed out by alternate pressure upon, and relaxation of, the rubber bottle. By this means the fragments of the stone are collected in the glass receptacle which forms part of the apparatus. The washing is continued until no more fragments are heard or felt to rattle against the end of the tube. It is often necessary to reintroduce the lithotrite in order to crush some

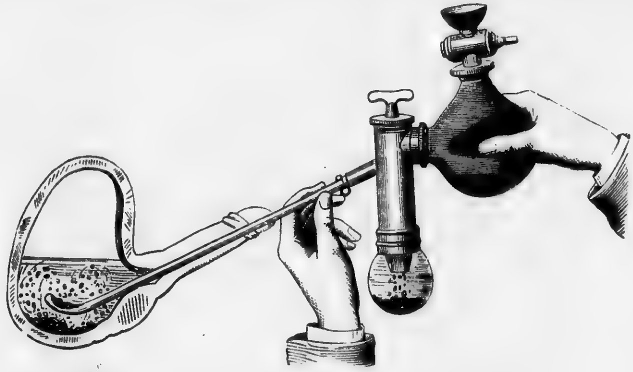


FIG. 347.—EVACUATOR IN POSITION IN THE BLADDER.

larger portions of the calculus still remaining; but the old practice of withdrawing small fragments within the grasp of a lithotrite is to be condemned. It is scarcely necessary to resound the bladder after the efficient use of the evacuator. A certain amount of bleeding is indispensable from these manipulations, but it is not excessive in careful hands. Should, however, considerable bleeding follow, the bladder is likely to become subsequently distended with clots, necessitating the use of a large-eyed catheter for their removal.

After-Treatment.—The patient is placed in bed as soon as the operation is completed, and kept warm and quiet, and suitable measures must be taken to combat shock. The diet is restricted to fluids for a few days, whilst pain, if complained of, may be relieved by a little morphia. If all goes well, he may be allowed to get up at the end of a week.

Various **Sequelæ** may occur after this operation. *Cystitis* results partly from mechanical causes, but more frequently from imperfect asepsis. The symptoms are usually subacute in character, and may pass away after a few days; but if due to sepsis, considerable constitutional disturbance may arise, and a large amount of viscid muco-pus is excreted, whilst the urine becomes alkaline and ammoniacal. In such a case it is absolutely essential to wash out the bladder once or twice a day, as if left to itself the condition is very liable to spread up the ureters, and may destroy the patient's life by suppurative nephritis. *Atony of the bladder* is occasionally induced, either by the operation or by a consequent cystitis, and is especially common in elderly individuals. It must be treated by regular and aseptic catheterism. Where the patient's kidneys are already affected prior to the operation, any of the conditions described under *surgical kidney* (p. 994) may be originated by it, even including suppression of urine.

Lateral Lithotomy is an operation which has always been of great interest to the surgeon, although at the present day it is comparatively seldom performed. The patient, having been suitably prepared, is anæsthetized, and the perineum shaved. A sound is passed so as to make certain of the presence of the calculus, and the bladder washed out, about 6 or 7 ounces of an antiseptic solution being left in. A fully curved staff, grooved on the left side, is introduced and handed over to the care of a trustworthy assistant. The patient is then, and not till then, placed in the lithotomy position, *i.e.*, his hands and ankles are approximated and held together by bandages or suitable shackles; a Clover's crutch is useful when the surgeon has not plenty of help. The staff is held in the assistant's right hand, the left hand being used to support the scrotum; the operator usually prefers the staff to be held well up under the arch of the pubes.

As a final preparation before commencing, the left index-finger is inserted into the rectum, partly in order to ascertain the depth of the perineum, and partly to see that the bowel is empty, and to induce contraction of its walls, and thus minimize the risk of injury by the knife. Of course the finger is afterwards carefully purified before placing it in the wound.

The superficial incision (Fig. 349) commences at a point 1½ inches in front of the anus, a little to the left of the central raphe, and extends downwards and outwards to a spot just external to the middle of a line from the anus to the tuber ischii, being deeper behind than in front, and dividing the skin, subcutaneous tissue, and inferior hæmorrhoidal vessels and nerves. The incision is carefully deepened by the section of any resisting bands until the transverse perineal nerves and vessels are cut through, as also the deeper layer of superficial fascia and anterior layer of the triangular ligament, which are continuous around the transversus perinei muscle. The left index-finger is then pushed on into the wound, so as to ascertain the position of the staff, and the knife is carried on towards it, and made to enter the groove at a point corresponding to the membranous portion of the urethra (Fig. 350). When once the knife is felt to be well in the groove it is pushed on into the bladder, the handle being depressed, and the blade somewhat lateralized. It is most important that the point and back of the knife should never leave

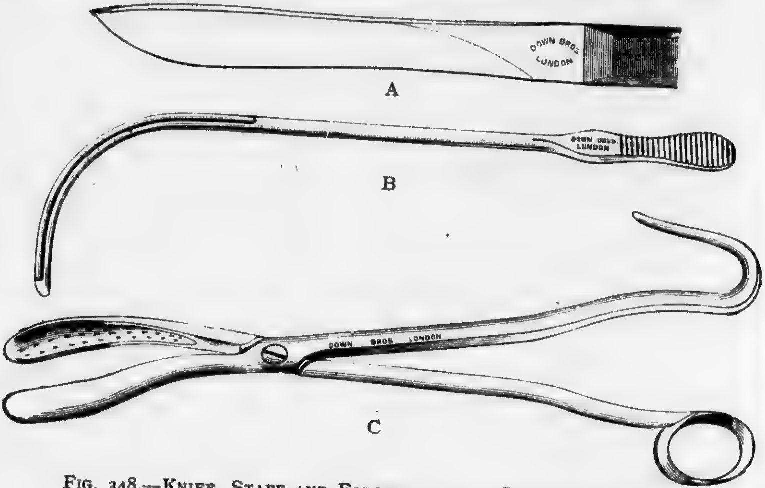


FIG. 348.—KNIFE, STAFF AND FORCEPS USED IN LATERAL LITHOTOMY. (DOWN BROTHERS.)

the groove in the staff, or the rectum is likely to be wounded; as it is passed onwards, the membranous portion of the urethra, together with the deep constrictor, is divided, as also the capsule of the prostate, whilst the left lateral lobe of that organ is freely notched. The knife is then carefully withdrawn. The left index-finger may now be inserted along the urethra into the bladder, keeping the finger-nail in the groove. The opening in the prostate is enlarged by twisting the finger once or twice as it lies in the wound. If possible, the surgeon feels the calculus with the tip of the finger, or, at any rate, satisfies himself that he has entered the bladder before the staff is withdrawn. After its removal the wound is still further dilated by rotation of the

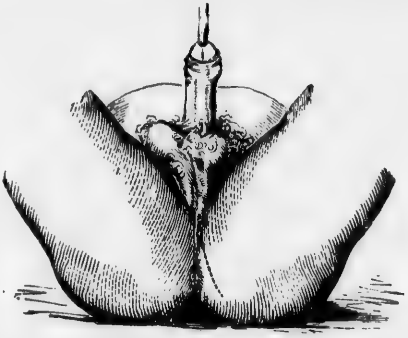


FIG. 349.—SUPERFICIAL INCISION IN LATERAL LITHOTOMY. (FERGUSSON.)

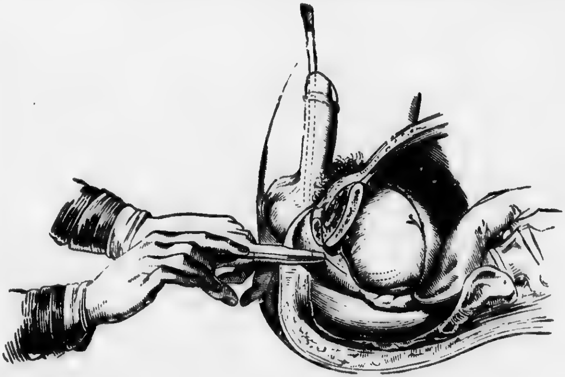


FIG. 350.—DEEP INCISION IN LATERAL LITHOTOMY. (FERGUSSON.)

finger, so as to facilitate the entrance of the lithotomy forceps, which is the next step in the proceeding. These are inserted by sliding them along the back of the index-finger, and when once introduced the finger may be withdrawn, being usually followed by a gush of lotion, which may carry the calculus into the grasp of the forceps. As a rule, however, it is necessary to feel for the stone, and grasp it by opening and closing the blades. The surgeon must then endeavour to manipulate the calculus, so as to have its shortest diameter presenting. The forceps, with the stone in its grasp, is then gently withdrawn by pulling well down along the axis of the pelvic outlet. Great care must be exercised not to use any undue violence, for fear of bruising and lacerating the neck of the bladder; gentle side-to-side movement is perhaps the best to employ. Should the calculus be larger than was at first expected, the urethra and prostate may be notched with a probe-pointed bistoury on the right side, so as to enlarge the aperture, or the tissues may be gently pushed back with the index-finger, whilst steady traction is exercised. If the calculus breaks into several pieces or if many calculi are present, the fragments may be removed by means of the finger and lithotomy scoop (Fig. 351). The bladder is now once more thoroughly searched, washed out with antiseptic, and all evident hæmorrhage stopped. In most cases it is now considered advisable to introduce through the wound a gum-elastic vaginal tube or a large catheter, which is left in position for a few days.

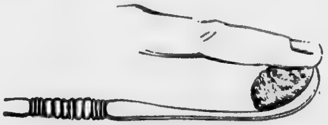


FIG. 351.—LITHOTOMY SCOOP, AND POSITION OF FINGER IN EXTRACTING STONE.

The **After-treatment** consists in keeping the patient quiet, with his legs tied together, a pad of wool being placed against the perineal wound, which is syringed out once or twice a day through the tube. When the wound begins to granulate, the tube may be removed; the urine escapes for a time through the perineal opening, which, however, contracts gradually, and closes in most instances in the course of two or three weeks. The patient should be kept on a light non-stimulating diet, with plenty of diluent drinks, such as barley-water.

Complications and Dangers of Lateral Lithotomy.—(1) *Hæmorrhage* may arise from three sources: the superficial arteries of the perineum, the deep branches of the pubic, especially that which passes to the bulb, and the veins of the prostatic plexus. The first of these are divided in the superficial incision, and may be readily secured, if necessary, by forceps and ligature. The artery to the bulb is not likely to be wounded if the incision is limited anteriorly according to the directions given above; if, however, this trunk or its branches in the bulb are cut, free arterial hæmorrhage follows, which is usually stopped without difficulty by opening up the wound and seizing the bleeding-points with forceps. The internal pudic artery runs but little risk of injury except in those cases where it follows an abnormal course; it is readily treated on general principles. Venous hæmorrhage from the prostate is a more serious matter, and is especially prone to occur in elderly persons with prostatic hypertrophy. It is recognised by venous blood welling up from the depths of the wound, or possibly, if not evident at the time of the operation, by the bladder becoming distended with clot, considerable pain being thereby induced. If noticed during the operation, it is treated by syringing out the wound with iced lotion, and the insertion of an air tampon or a petticoated tube. The former contrivance consists of a gum-elastic catheter, the deep portion of which is surrounded by an indiarubber bag, which can be inflated with air through a small tube fitted with a stop-cock, to which a force-pump can be attached. The petticoated tube is used when the latter is not obtainable or fails to act; it is made by tying a petticoat of lint or gauze around the distal end of a vaginal tube; this is then passed into the bladder, and the space between the petticoat and the tube packed with gauze. If the bladder becomes filled with blood-clot, this must be broken up and removed by syringing with hot water through a large-eyed catheter, and the wound subsequently plugged around a catheter. (2) A *Wound of the Rectum* may be caused by carrying the superficial incision too far backwards, or by keeping it too near the middle line behind; or it may occur later in the operation by not keeping the point of the knife strictly in the groove. It is more liable to happen, however, whilst withdrawing the knife, the point being swept backwards, thus opening the bowel; it most frequently happens to boys. It is often not recognised except by the passage of flatus and fæces through the wound later on. If of small size and situated low down, it will probably close by cicatrization without special treatment; but when high up and more extensive, a recto-vesical fistula is likely to follow. The treatment usually recommended in such a case is to divide the sphincter, and thus lay the lower end of the rectum and the lithotomy wound into one cavity, the communication being sometimes closed by the contraction of the granulation tissue which fills up the wound. In suitable cases it may be possible to stitch up the opening from the rectum after paring its edges. (3) *Pelvic Cellulitis* may be caused by cutting beyond the limits of the prostate, and thus opening up the recto-vesical fascia, or by bruising and overdistension of the neck of the bladder by dragging through it too large a stone. In either case urinary extravasation and diffuse septic inflammation are likely to follow, resulting in grave constitutional disturbance of a septic nature, and possibly in the death of the patient. The treatment suggested is to support the patient's general health by suitable diet and stimulants, whilst local tension is relieved by extending the wound backwards, even into the rectum. (4) *Septic Cystitis*, and extension of the inflammation to the kidneys, may occasionally supervene, whilst life may be also destroyed by shock, suppression of urine, or pyæmia.

Lateral Lithotomy in Boys was formerly considered one of the most successful major operations in surgery, but at the present time it has been proved that lithotrity can be equally well practised, provided suitable instruments are employed and the external meatus is incised. Should a cutting operation be called for, the high position of the bladder lends itself most favourably to the suprapubic method, which is now extensively practised. The chief peculiarities of lateral lithotomy in boys consist in the rudimentary nature of the parts involved, and in the fact that the bladder is an abdominal rather than a pelvic viscus. Hence the deep incision always travels beyond the limits of the prostate, whilst the knife has to pass relatively higher than usual in order to reach the bladder. Considerable difficulty is also experienced in touching the stone with the finger, and if much force is used, the neck of the bladder may be torn through, and fatal cellulitis ensue. Atrophy of the left testis has happened as a sequela of this operation owing to section of the ejaculatory duct in the prostate.

Suprapubic Cystotomy is an operation which has been extensively practised of recent years, and with considerable success. The chief difficulty consists in displacing the anterior reflection of the peritoneum, so as to expose the bladder without injuring it. Two methods have been adopted in order to overcome this difficulty: (*a*) The rectum is distended by means of Petersen's indiarubber bag, which is capable of containing 10 or 15 ounces of water, whilst the bladder is also injected with 6 to 10 ounces of fluid. This plan is not always successful, and, indeed, the rectum has been injured, and even ruptured. Hence it is now discarded in favour of (*b*) *Trendelenburg's position*. The bladder is washed out, and 8 or 10 ounces of lotion left within it; the patient is then placed with the pelvis raised well above the head, the intestines being thus allowed to gravitate to the postero-superior part of the abdomen; as soon as the abdominal parietes are opened, air rushes in to the connective tissue behind the symphysis (cavum Retzii), and the peritoneum is thus pressed back.

Operation.—The pubes having been previously shaved, and the hypogastrium purified, an incision is made in the median line reaching from the top of the symphysis upwards for about 2 or 3 inches; the lower part of the linea alba is divided, and the retro-pubic cellular tissue opened up. The entrance of atmospheric air into this cavity further assists in the depression of the peritoneum. The tense rounded outline of the bladder can now be readily detected with the finger, and a couple of lateral silk sutures or slings are passed through its walls so as to steady it and prevent its subsequent retraction. An opening is then made into it in the middle line, through which the index-finger is passed and the stone examined. Suitably curved lithotomy forceps are now introduced, and the stone grasped and withdrawn. The after-treatment of the wound is a point on which much difference of opinion has been expressed. Some leave it open, allowing it to heal by granulation; this is especially advisable if much cystitis is present. When, however, the bladder is tolerably healthy, it may be closed by sutures, which only pass through the muscular and submucous coats, and thus when tied do not project into its cavity. The external wound may then be left open or closed, except at the spot where a drainage-tube or gauze wick is passed down to the vesical wound, so as to allow exit to any urine which may accidentally become extravasated. The urine is either drawn off by a catheter at regular intervals, certainly not less than three or four times daily, or the bladder is drained by tying in a catheter.

Choice of Operation for Vesical Calculus.—At the present day lithotrity has been brought to such a standard of excellence that there is no doubt as to the general rule which should be followed, viz., that *unless some contra-indication is present, all cases of vesical calculus should be treated by lithotrity.*

The **Contra-indications to Lithotrity** are as follows: (1) *Conditions of the Stone.* If the calculus exceeds 1½ inches in diameter, it is not advisable to attempt lithotrity on account of the damage which is likely to occur to the vesical wall. Moreover, some stones, especially those consisting of oxalate of lime, are so hard that no lithotrite can crush them. Phosphatic concretions, on the other hand, are so soft that a lithotrite becomes clogged, and crushing is impracticable. An encysted stone will also preclude lithotrity on account of its fixed position. There is no objection to dealing with multiple calculi by this means, but if only of small size, they may be removed by simply using the evacuator. (2) *Conditions of the Urethra.* The existence of an organic stricture, or an enlarged prostate, may render lithotrity impracticable from the impossibility of passing large enough instruments, whilst false passages may make it exceedingly difficult. Excessive irritability of the urethra, as evidenced by the occurrence of severe rigors after instrumentation, may also render the operation unadvisable. (3) *Conditions of the Bladder.*

The existence of severe cystitis or the presence of sacculi, as indicated by the cystoscope, will usually suggest the performance of lithotomy; whilst a contracted bladder, which will only hold a few ounces of urine, materially increases the dangers and difficulties of lithotrity.

Having thus described the conditions which contra-indicate lithotrity, a choice must be made between entering the bladder from the perineum or above the pubes.

Indications for Lateral Lithotomy.—(1) Where the stone does not exceed 1¼ to 1½ inches in its maximum diameter. (2) Where great irritability of the bladder and cystitis are present, the incision facilitating the process of draining and washing it out. (3) The presence of a phosphatic concretion. (4) A contracted and hypertrophied condition of the bladder.

Suprapubic Lithotomy should be undertaken under the following conditions: (1) Where the stone exceeds 1½ or 1¾ inches in diameter; (2) where the stone is encysted; (3) where a stricture or enlarged prostate is present; (4) where lateral lithotomy is rendered impracticable on account of pelvic conditions, such as rachitic contraction or the existence of a tumour, or where the left hip-joint is ankylosed, preventing the patient assuming the lithotomy position. Suprapubic cystotomy is only absolutely contra-indicated by two conditions, viz., severe septic cystitis and contraction of the bladder.

Calculus in the Female.—As already mentioned, vesical calculus is very rare amongst women, owing to the shortness and greater size of the urethra, so that small stones passing downwards from the kidneys are easily voided. Phosphatic concretions are not uncommon, and are then formed around a foreign body usually introduced by the patient. Many of the symptoms are very similar to those in the male.

Treatment.—If the calculus does not exceed ½ to ¾ inch in diameter, it can usually be extracted by dilating the urethra with the finger, the sphincter being also nicked in two or three places if necessary. It is never wise to totally divide the sphincter, as incontinence is almost certain to follow. For a somewhat larger stone lithotrity can be undertaken, whilst for those of really large size suprapubic cystotomy is the best procedure. It has been recommended to open the bladder through the anterior vaginal wall, and thus remove a stone; but this is scarcely desirable, for fear of the persistence of a vesico-vaginal fistula.

Affections of the Prostate.

Acute Prostatitis arises most usually as a sequela of gonorrhœa, either in its acute or chronic stage, by direct extension backwards of the inflammatory process; it is also occasionally met with as a result of stricture arising from the irritation of retained and decomposing urine, or from the passage of instruments. It is also said to be induced by the application of cold or damp to the perineum, as by sitting on cold stones or damp grass, but probably this has been preceded by bacterial invasion of the posterior part of the urethra.

The **Symptoms** consist of deep-seated pain referred to the neck of the bladder, with perhaps a sense of weight and fulness about the perineum. Micturition becomes frequent and painful, and defæcation may cause considerable distress. As the organ increases in size, the pain becomes more and more severe, and all movements of the body, as also the act of sitting, become increasingly difficult. On rectal examination, the organ can be felt enlarged, hot, and tender. Suppuration is likely to follow, and retention of urine may be thereby induced. The abscess either bursts into the urethra spontaneously, or is ruptured by the passage of a catheter for the relief of retention; the opening, however, is often of a valvular nature, and only a small portion of the pus escapes. The process may then continue to spread, and the pus may find its way into the rectum, or come to the surface through the perineum. In either of the latter conditions, a rectal or perineal fistula sometimes results. Considerable constitutional disturbance is usually associated with this affection, whether suppuration occurs or not.

Treatment.—The patient should be kept in bed on a restricted diet, and the bowels freely opened by saline purges, combined with small doses of antimony, and perhaps full doses of hyoscyamus. Local depletion may be undertaken by cupping the perineum, or by applying ten or twelve leeches to it. Hot hip-baths are also very valuable, and linseed-meal poultices may be placed on the perineum after the leeches have been removed. Extreme pain should be relieved by the use of morphia suppositories, and if the urine needs to be drawn off, a soft rubber catheter of small size should be used. If an abscess forms and is not opened by the passage of a catheter, or if the natural opening is of a valvular character, so that the cavity cannot completely empty itself, an incision must be made into it through the middle line of the perineum, being guided by a finger placed in the rectum; pus may not be reached until the knife has entered to a depth of about 2 inches. Urine will sometimes escape from this opening, and may continue to do so for some considerable time. If gonorrhœa is also present, suitable treatment must be adopted in order to check the discharge.

Chronic Prostatitis is perhaps one of the most common causes of gleet. It is sometimes left as a sequela of an acute attack, or may arise as a result of stricture.

The **Symptoms** produced by it are a sense of weight and fulness about the perineum, combined with irritability of the bladder, and pain referred to the extremity of the penis at the end of micturition, owing to the bladder contracting upon the hyperæmic and sensitive organ. A glairy discharge of viscid material, similar in appearance to uncooked white of egg (*prostatorrhœa*), is often present; whilst, on examining the urine, fine threads of mucus are usually seen floating within it, being due to the formation of mucous casts of the prostatic ducts. On examination through the rectum, the organ can be felt enlarged and tender, and the vesiculæ are usually in the same condition. Chronic suppuration may also follow, the abscess bursting into the urethra or rectum, or pointing in the perineum.

The **Diagnosis** from tubercular disease is difficult, but can usually be made out by careful attention to the history and physical signs.

Treatment consists in counter-irritation of the surface of the perineum, as by blisters or iodine paint, care being taken that the reagent employed does not extend either to the anus or scrotum. Belladonna suppositories may be of value, whilst the occasional passage of a cold metal bougie may do good. In suitable cases, where a long-standing gleet is present with no suspicion of suppuration, a cure may occasionally be brought about by the administration of iodide of potassium, or of the liq. ferri perchloridi (♏ xv. or more, t.d.s.), combined with sulphate of magnesia. The local application of a solution of nitrate of silver by a porte-caustique is also sometimes recommended, but we are not much in favour of such a proceeding. Should an abscess form, it may be incised through the perineum.

Tubercular Disease of the Prostate is usually met with as a result of extension from similar disease in the epididymis, the seminal vesicles being also invaded; occasionally, however, it may arise as a primary affection. In either case, it rapidly spreads to the bladder, and thence to the ureters and kidneys. The prostate is found to contain caseous masses in the early stages, but later on these break down, leading to extensive ulceration, and sometimes the organ is riddled with ragged cavities. The symptoms produced are those of irritability of the neck of the bladder, combined with pain referred, perhaps, to the end of the penis, or mainly noticed in the back or perineum. Hæmaturia is occasionally produced, whilst pyuria is almost constant. The urine is feebly acid or neutral, and, on examination of the pus which is deposited on standing, the tubercle bacillus may be detected. Rectal examination will demonstrate an irregular enlargement of the organ, whilst if the vesiculæ are invaded, they can also be felt.

Treatment consists in attending to the general health, and the administration of tonics. Possibly, if the disease is not too extensive, benefit may be derived from scraping the tubercular tissue away through a perineal incision.

Prostatic Calculi are of unfrequent occurrence, being usually met with in cases of chronic prostatitis, especially that resulting from stricture of the urethra or previous attacks of gonorrhœa. They are generally multiple, and of small size, consisting mainly of carbonate of lime. They develop primarily in the glandular crypts, and may remain embedded in the organ, and give rise to but little inconvenience. When large and protruding from the gland into the urethra, symptoms of obstruction to the flow of urine are produced, whilst on passing a catheter or sound a distinct click or grating may be noticed. In the latter case, great irritability of the neck of the bladder is induced. Sometimes a number of them are found in a pouch or pocket, formed by the amalgamation of several of the crypts. It is in some instances possible to remove the calculi through the urethra, but more frequently a perineal incision is required.

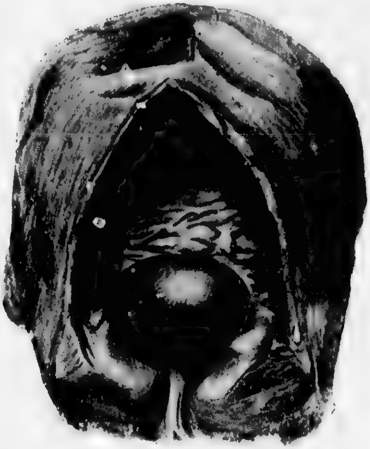


FIG. 352.—ENLARGED PROSTATE; MIDDLE LOBE REPLACED BY ENORMOUS FIBROMYOMA. (FROM COLLEGE OF SURGEONS MUSEUM.)

Hypertrophy of the Prostate is a condition rarely met with, except in patients over fifty years of age. There is a general enlargement of the tissues of the part, involving either the glandular and the muscular elements equally, or especially limiting itself to one or other of these tissues; more frequently the muscular element is considerably in excess. Another variety is due to the development of localized tumours in, or outgrowths from, the organ, which are usually fibro-myomatous in nature, particularly if embedded in the prostatic substance; when of this type they are almost exactly analogous to the so-called fibroid tumours of the uterus, since they originate in the walls of the sinus pocularis, the male analogue of that organ. These tumours are rather denser than ordinary prostatic tissue, and are often completely encapsuled. They are primarily developed in the substance of the prostate, but tend to project outwards, when large, towards the rectum, or grow upwards into the bladder (Fig. 352), or may even become pedunculated, constituting a polypus in the dilated urethra. Occasionally these new growths consist mainly of glandular tissue with distinct ducts, and possibly concretions may be found in the tubules. There are thus, pathologically speaking, three main forms of the so-called 'chronic hypertrophy of the prostate': the diffuse enlargement, the fibromyomata, and the adenomata; not unfrequently they are combined one with the other.

The changes produced in the prostatic urethra and neck of the bladder vary considerably according to the character of the outgrowth in any particular case. A certain amount of obstruction is always present, except in a few instances in which the internal meatus becomes unduly patent, possibly as a result of a tumour in the median portion becoming wedged in between the two lateral lobes. The prostatic urethra in all cases of this disease becomes increased in length. When the lateral lobes are enlarged, the lumen of the urethra is diminished from side to side, being narrow or chink-like instead of circular; its vertical measurements are, however, increased. The urethra is, moreover, rendered more or less tortuous, owing to irregular enlargement of the various portions. Thus, if the median lobe is especially prominent, a rounded barrier extends across the urethra, which becomes almost S-shaped (Fig. 353, B). If one lateral lobe is enlarged more than the other, the urethra is pushed over towards the unaffected side. *The shape of the internal meatus* is also considerably modified; when the median lobe is enlarged, it becomes crescentic, the convexity looking upwards and forwards; when one lateral lobe is of larger size than the other, the orifice is also crescentic, the convexity being directed towards the smaller lobe; when all three lobes are affected, the entrance to the bladder may be Y-shaped, the limbs of the Y passing on either side of the

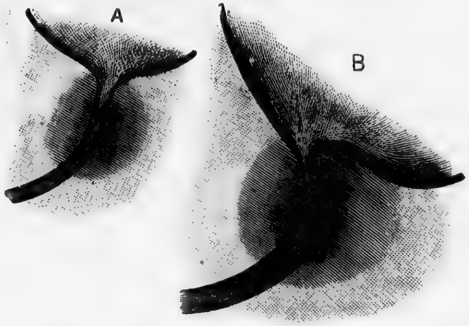


FIG. 353.—EFFECT OF ENLARGEMENT OF THE MIDDLE LOBE OF THE PROSTATE ON THE COURSE OF THE URETHRA. (DIAGRAMMATIC.)

The left-hand figure represents the normal curve of the urethra; that on the right side, the barrier caused by an enlarged middle lobe.

median lobe. Not unfrequently the prostate may project into the bladder as a rounded, collar-like elevation, encircling the meatus.

The **Symptoms** vary considerably according to the nature and position of the enlargement. The patient at first finds some difficulty in micturition, especially at the commencement of the act; straining often hinders rather than assists. The stream is not necessarily smaller than formerly, but is projected with less force. Gradually irritability of the bladder ensues, and the patient is called upon to pass water very frequently, especially during the night. Some degree of pain and a sense of weight and fulness about the perineum are also experienced, whilst tenesmus, and even hernia, may be subsequently induced by the straining. As the obstruction increases, a certain amount of residual urine remains within the bladder after each act of micturition. If this condition remains untreated, the bladder becomes distended, the urine dribbling away and wetting the clothes, or decomposition of the retained fluid may follow, and cause cystitis with increasing vesical irritation and muscular spasm. The urine becomes alkaline after a time, containing muco-pus and phosphates, the result of chronic cystitis. This, if neglected, is certain to lead to hydronephrosis and surgical kidney. Gradually the general health of the patient is undermined by the constant irritation produced by this process, as also by septic absorption, and the final chapter may be ushered in by symptoms of uræmia from the mischief inflicted on the kidneys.

Occasionally the early symptoms may pass unnoticed for a considerable time, the patient imagining that the frequent calls to pass water are good signs rather than evidences of disease. In such cases the bladder may become over-distended, and the condition unsuspected until, owing possibly to some exposure to cold or over-indulgence in alcohol, complete retention is induced, and then, to the surprise of the patient, an enormous amount of urine is withdrawn on the passage of a catheter. Priapism is sometimes a troublesome condition, and the effect of this on the moral sense may be very serious, and leads in some cases to acts of gross indecency.

The **Diagnosis** of enlarged prostate is made partly by a consideration of the symptoms complained of, but mainly by an examination by the urethra and rectum. The age of the patient, the increasing irritability of the bladder, by night and day, the fact that straining hinders rather than helps the expulsive act, together with evidence of distension of the viscus—all these facts tend to indicate that the seat of obstruction lies in the prostate gland. A rectal examination is then instituted, and some idea gained of the size and condition of the organ; it must not be forgotten, however, that the size, as recognised by a finger in the rectum, cannot measure in any way the amount of obstruction to the passage of the urine, and, in fact, it often happens that where the gland does not feel especially large from the rectum, the obstruction is the greatest. The careful introduction of a catheter will assist in making the diagnosis, inasmuch as the barrier at the neck of the bladder is easily detected, and sometimes with difficulty passed.

Treatment.—All that is needed at first is regular catheterism, in order to prevent the bladder from becoming overdistended, and this the patient may sometimes be taught to do for himself. To pass a catheter on a case of enlarged prostate is not always easy, owing to the fact that the middle lobe projects across the urethra, and bars the onward progress of an instrument of the ordinary shape. In such cases the surgeon should use either a catheter coudé or bicoudé (Fig. 354), which consists of a soft, straight instrument of the usual French type, the end of which is bent or doubly bent at an angle, so as to enable it to ride over the obstruction; or he may employ an English gum-elastic catheter, the stilette of which is drawn out a little so as to increase its curve; or he may utilize the silver prostatic catheter, which is longer and more curved than usual, depressing it well between the thighs after clearing the pubic arch. Whichever method is adopted, no force is required, since, with a little skilful manœuvring, the point of the instrument will pass round the obstruction and enter the bladder. Every precaution must be taken to ensure the efficient sterilisation of all instruments employed.

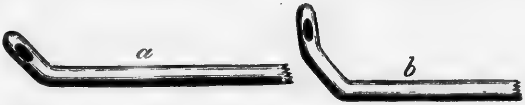


FIG. 354.—CATHETER COUDÉ AND BICOUDÉ.

During the first fortnight of catheter life the patient must be carefully guarded from cold and exposure, to avoid the occurrence of constitutional disturbance. Not unfrequently a certain amount of fever (to which the name of **Catheter Fever** was given by the late Sir Andrew Clark) is produced, which either passes off in the course of a few days, or may increase, together with symptoms of chronic cystitis, running on to a fatal issue at the end of three or four weeks. The origin of this condition is still somewhat doubtful; it may certainly arise from the absorption of micro-organisms or their products from the urethra, or from the use of impure instruments, but possibly reflex nervous disturbance plays some part in its production. The only treatment required in the simpler cases is to keep the patient warm in bed, to limit his diet, to administer quinine and opium, and to keep the bowels well open.

During the continuance of catheter life, the patient must be warned to live quietly, and abstain from all excesses, especially as regards eating and drinking; sexual excitement should be avoided, and horse-exercise forbidden; precautions must also be taken to protect the patient against cold and damp. The administration of alkalies is most desirable to counteract the acidity of the urine, and thereby diminish the irritability of the bladder.

Under such a régime, it is probable that comparative comfort may be enjoyed perhaps for years, the progress of the affection being entirely checked in some instances. This, to a large extent, depends upon the bladder remaining free from septic contamination, and the surgeon must realize and impress upon his patient that such is generally due to infection from without, and hence the most scrupulous care must be taken in sterilizing all instruments before and after use. In other cases the relief is but temporary, and after a time the irritability of the bladder increases to such an extent that further measures are absolutely imperative.

Two chief plans of operative treatment have been adopted in this affection, both directed to reducing the size of the organ, and thus removing the obstruction to the passage of urine: in the one, the gland itself is attacked, and portions of it removed or divided (prostatotomy or prostatectomy); in the other, the diminution in size is attained by indirect measures.

Prostatotomy, or incision of the prostate, is usually undertaken from the perineum. The ordinary incision for median cystotomy is made after the passage of a staff with a median groove. The membranous urethra and prostate are divided in the middle line to a sufficient extent to allow of the introduction of the finger into the bladder, and an elastic tube is then inserted for drainage. Any projecting nodules or masses of prostatic substance that can be detached are removed. The drainage is maintained for a week or ten days, and considerable improvement is said to follow in some cases. The chief objection to this plan is that the perineum in these patients is often so deep that it is impossible to insert the finger into the bladder; considerable hæmorrhage may also take place, whilst it is difficult to remove tumour masses that might be easily enucleated by other means. The chief indication for its use is when cystitis is present to such a degree as to necessitate continuous drainage.

It has also been proposed to divide the obstruction at the neck of the bladder by a concealed knife, to destroy it by a galvano-cautery (Bottini's method), or snare it when pedunculated; such proceedings are uncertain, and not free from risk.

Prostatectomy, or removal of the prostatic enlargement, has been introduced as a means of treatment during the last few years. It is usually conducted through a suprapubic incision into the bladder, the patient being previously placed in the Trendelenburg position. The enlargement at the neck of the bladder can be felt, and, by the use of suitable illuminating apparatus, seen. Projecting growths may be incised and shelled out without much difficulty or hæmorrhage; whilst if the whole organ is enlarged, the mucous membrane over it may be divided by a circular incision, the gland substance cut through in front and behind with scissors, and the whole mass enucleated by the use of a suitable scoop, or with the fingers. The passage of a catheter along the urethra enables the surgeon to ascertain that the whole of the projecting growth has been removed. Most satisfactory results have followed this operation, although sometimes severe hæmorrhage has occurred. It is most suitable to cases in which a pedunculated or encapsuled tumour exists in the middle lobe.

The chief measures which have been employed for reducing the size of the prostate **by indirect means** are as follows:

(*a*) *Double Castration.*—This plan was first suggested by White of Philadelphia, in 1894, and has now been followed to a sufficient extent to enable us to come to some decision as to its utility. It has long been known that uterine fibroids diminish in size after removal of the ovaries, and the similarity between such growths and an enlarged prostate would lead one to anticipate that if the testes are excised a similar shrinking of the prostate might follow; such, in certain instances, has been found to be the case. The conditions most favourable to double castration are those in which the whole gland is enlarged, soft and vascular, bleeding readily on the introduction of a catheter; on the other hand, hard prostates, or those in which fibroid tumours are present, are not likely to be much improved by this proceeding.

(*b*) In order to overcome the natural objection of patients to the removal of their testes, *vasectomy*, or the excision of a portion of the vas deferens on each side, has been practised. In suitable cases the results have been good, but the effects are attained more slowly than after castration.

(*c*) Ligature of the internal iliac arteries has also been employed in order to starve the gland, and certainly in a few instances with success.

The actual treatment to be adopted in any particular case must be determined by its special features. Catheterism will suffice for a time, but when this fails operation should be undertaken. For localized outgrowths projecting into the bladder, and recognised by the cystoscope, suprapubic prostatectomy is to be recommended; but for general enlargement of the organ, especially if it is soft and succulent, vasectomy should first be performed, and may be followed up by double castration, if necessary.

Finally, if the patient refuses these operations, or if his general condition prevents them from being undertaken with safety, and catheterism is insufficient to give relief to his symptoms, a *permanent fistula* either above the pubes or through the perineum must be established, necessitating the use of a portable urinal. This is effected by introducing a trocar and cannula into the bladder, and leaving it there until a sufficient track has been formed.

Cancer of the Prostate occurs in elderly men, but is not common; it is usually of a scirrhous type. The symptoms produced are those of obstruction to the flow of urine, together with pain, which may be very severe, and at a later date hæmorrhage. The progress of the disease is much more rapid than in senile hypertrophy. On rectal examination the hard mass is readily detected, whilst secondary deposits may be found in the lumbar and abdominal glands on palpating the abdomen. Occasionally phenomena referable to pressure on the abdominal vessels and nerves arise, and the symptoms of general cachexia soon manifest themselves. Palliative treatment alone can be adopted.

CHAPTER XXXVI.

AFFECTIONS OF THE URETHRA AND PENIS.

Affections of the Urethra.

Congenital Malformations.—**Total Absence**, or **Occlusion**, of the urethra has been met with, the urine under such circumstances being sometimes retained, and leading to dilatation of the bladder, ureters, and kidneys, a condition rapidly fatal, even if the child be born alive. In a few cases the urachus remains patent, and a congenital urinary fistula is established at the umbilicus, whilst in others the cloacal condition persists, the urine passing into the rectum.

Epispadias is a deformity in which the upper wall of the urethra is partially or wholly defective. In rare instances the external meatus is situated just above the glans, which is cleft and deeply grooved superiorly. More commonly the urethra opens at the root of the penis, just in front of the symphysis, and in such patients the penis is always rudimentary and stunted. Complete epispadias is only present when associated with extroversion of the bladder (p. 1003). The incomplete form has been treated with success by the use of reversed flaps dissected up from the side of the penis. For details of the operations on this and the following conditions, see larger text-books on operative surgery.

Hypospadias, or defective development of the lower wall of the urethra, is a much more common malformation than the foregoing. Three varieties are described. In (*a*) *hypospadia glandis* the opening of the urethra corresponds to the position usually occupied by the frænum, and is thus directed downwards instead of forwards. The prepuce in these cases is always voluminous, and hangs like a hood over the glans, which is bent down over the orifice. (*b*) *Hypospadia penis* is characterized by the urethra opening somewhere along the under surface of the body of the penis, which is often small and stunted. Considerable discomfort may arise in the act of micturition owing to the urethral orifice looking downwards; it is also sometimes so small as to require incision and dilatation. (*c*) Complete hypospadias, or *hypospadia perinealis*, is a somewhat complicated condition, in which the lower wall of the urethra is defective as far back as the perineum, the scrotum being cleft, and thus resembling the vulva. The penis is always small, imperfectly developed, and bound down by adhesions between the scrotal segments, looking not unlike a hypertrophied clitoris. Under such circumstances it is not surprising that the sex of the child has been mistaken, and not a few cases are on record where it has been educated as a female until the age of eighteen or twenty. Non-descent of the testes is often associated with this malformation.

In the incomplete varieties, where the deformity is slight and the urethral opening well in front of the scrotum, no interference is necessary; but where it encroaches on the scrotum, causing inconvenience and discomfort, and threatening to prevent effective sexual intercourse in the future, the restoration of the urethra may be attempted by the use of reversed flaps obtained from either side, or from the redundant prepuce. In the complete form the penis must first be liberated from its adhesions and set free; the integument lining the scrotal cleft is then dissected up and turned inwards to form the posterior part of the urethra, whilst the lateral halves of the scrotum are brought together with sutures; the anterior portion of the urethra may then be dealt with as for the incomplete variety.

Traumatic Laceration of the Urethra is met with as a result of injury applied directly to the perineum, as by falling astride a stile, fence, or beam; it has also been caused by severe jolting in the saddle, or by a kick in the perineum. In fractures of the pelvis it may be produced by a spicule of bone puncturing the canal, and the membranous portion is that generally affected. The whole circumference of the urethra may be involved, the two segments being entirely disconnected, or only a portion may be ruptured, and that most frequently the floor.

The **Symptoms** consist of pain in the perineum and shock, followed by great distension of the scrotum from hæmorrhage, whilst blood trickles from the urethral orifice. If the patient is able to restrain himself from passing water, and is successfully treated, no extravasation of urine results, since the lesion is below the sphincter vesicæ; if, however, he attempts to micturate, the urine finds its way into the perineal and scrotal tissues. Whether the rupture is complete or not, an organic stricture of considerable density is almost certain to follow, and great difficulty is subsequently experienced in keeping it dilated.

Treatment.—An attempt must always be made at the earliest possible moment to pass a catheter into the bladder; when the rupture is incomplete, this may often be accomplished by keeping the point of the instrument against the roof of the urethra. If successful, the catheter is tied in this position for three or four days, until the wound is covered over with plastic lymph or granulation tissue, by which time the risk of extravasation will have practically ceased. The instrument is then removed, but a full-sized catheter should be passed daily for some time, and this must be occasionally repeated, even after all signs of the injury have disappeared. In spite of all precautions, however, the urine often finds its way along the side of the catheter to the neighbourhood of the wound, where it may do no harm, or may determine the formation of a perineal abscess.

If a catheter cannot be introduced, or if extravasation has occurred, free incisions must be made into the scrotum and perineum to give exit to the blood and urine, and to expose the seat of injury. A catheter is passed as far as possible, and its point felt for, cut down on, and guided into the bladder; a prolonged attempt under anæsthesia may be necessary to accomplish this. Occasionally, and especially if treatment has been delayed, the swelling of the parts is so great as to render this impracticable. The patient must then be put to bed for a few days until the blood-clot has disappeared, the urine in the meantime escaping through the perineal wound; but as soon as possible another attempt must be made. When once the catheter is passed, it must be retained for several days, so as to establish the continuity of the tube.

Foreign Bodies are sometimes found in the urethra, usually consisting of a portion of catheter, pipe-stem, or in children a piece of slate-pencil. Their presence gives rise to partial or complete obstruction to the flow of urine, followed by ulceration of the mucous membrane, the formation of a peri-urethral abscess, or even extravasation. They are readily detected on the passage of a sound or catheter, and may be removed by suitable urethral forceps if situated near the orifice. Should this fail, the urethra may be incised and the body extracted; a troublesome urinary fistula is apt to follow this proceeding, even when the wound in the urethra has been carefully sutured.

Impacted Calculus is a not unfrequent cause of retention in children. It can usually be felt through the walls of the canal. The symptoms and treatment are much the same as for foreign bodies. When near the neck of the bladder, it should be pushed back into that viscus, if possible, and treated by lithotrity.

Simple Urethritis may arise from a variety of causes apart from gonorrhœa, *e.g.*, the presence in the female of an irritating vaginal discharge, such as leucorrhœa, and possibly due to the *Bac. coli.* It also occurs after the passage of an instrument or of a calculus, and is occasionally excited in gouty individuals by highly acid urine. The symptoms are much the same as those of gonorrhœa, but the discharge is thinner in character, and on microscopical examination no gonococci are detected. The treatment consists in the administration of a simple saline purgative, all forms of alcohol being interdicted. In more severe cases oleo-balsams may be prescribed, and even mild injections.

Polypoid Tumours, similar in character to the caruncle met with in the urethra of women, have been observed at the orifice of the male urethra. They are red, vascular, and sometimes exceedingly painful, and are best dealt with by excision, followed by the application of the galvano-cautery, so as to stop the bleeding, which is always copious. If of large size, the base may be ligatured, and the growth then cut away.

Stricture of the Urethra.—By stricture of the urethra is meant a condition in which the onward passage of urine is hindered, owing to some change in the walls of the urethra, which prevents them from dilating. When at rest, the urethra is merely a potential canal, the walls of which are in complete apposition, and it is only converted into a tube when urine is passing along it. When, owing to some change in the structure of its walls, this functional dilatation is impracticable, the patient is said to suffer from stricture. Three forms of stricture are described, viz., the spasmodic, congestive, and organic.

Spasmodic and *Congestive Strictures* frequently co-exist, although either congestion or spasm may be the predominant feature in any particular case. Thus, in acute gonorrhœa the mucous membrane often becomes engorged and thickened to such an extent as to interfere with the act of micturition. Spasm is the chief element under the following conditions: (1) When a patient, suffering from slight organic stricture, is exposed to wet or cold, especially after heavy drinking; (2) after operations on the rectum or spermatic cord; (3) as a result of catheterism; and (4) from perineal irritation of the urethra, as by a blow or a kick in this region, or from prolonged riding on a bicycle with a badly fitting saddle or on horseback. Temporary retention is the usual result of any of these conditions, and, as a rule, no treatment is required beyond placing the patient in a hot bath, and unloading the lower bowel by the use of a large warm enema. If such fails, catheterism will be necessary, and must be conducted with the greatest gentleness, owing to the congested and lacerable condition of the mucous membrane. Full-sized soft instruments should first be used, and will usually succeed; if not, a silver instrument must be substituted.

Organic Stricture is the term applied to an undilatable condition of the urethra, resulting from the development of cicatricial tissue within its walls.

The **Causes** of organic stricture are: (*a*) the long continuance of a urethral discharge, following gonorrhœa, or the frequent recurrence of this affection. Chronic inflammations are always characterized by a tendency to sclerosis of the tissues involved, and the urethra is no exception to this rule, its walls under these circumstances becoming thickened, indurated, and contracted. (*b*) The cicatrization of a urethral chancre or of an ulcer, caused by the impaction of a stone, or the contraction produced by the healing of a urethral abscess, may also lead to stenosis. (*c*) The most intractable forms of stricture are those due to cicatrization after rupture or laceration of the urethral wall.

The usual **Situation** is within the bulb, *i.e.*, just in front of the triangular ligament; but the orifice and body are not unfrequently affected. It occurs in the membranous portion only as a result of traumatism, and never in the prostatic. To find more than one or two strictures in any particular case is unusual, although three or four have been met with.

Various terms are applied to strictures, according to the physical conditions present; thus, it is termed *annular*, if it involves the whole lumen of the urethra; *bridled*, if it affects only a portion of the circumference of the tube. A *ribbon-shaped* stricture is one in which a considerable extent of the wall is contracted (*i.e.*, as if a ribbon had been tied around the urethra). It is termed *tortuous*, if the resulting passage is not straight; *indurated*, if the walls are very hard and thickened; and *resilient*, when the stricture, though readily dilated, rapidly re-contracts. The terms *impassable* and *impermeable* are applied to strictures through which, on the one hand, a surgeon is unable to pass an instrument, or along which, on the other hand, urine cannot find its way; it is doubtful whether the latter condition ever occurs, whilst the number of impassable strictures met with by the surgeon diminishes with his experience and ability for passing instruments.

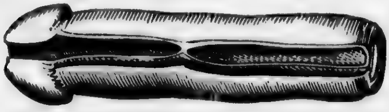


FIG. 355.—STRICTURE OF THE URETHRA.

The **Symptoms** of urethral stricture vary according to the case. The patient generally complains of difficulty in the act of micturition, the stream becoming small, and perhaps forked and twisted. It takes a longer time than usual to empty the bladder, and even when apparently successful a few drops of urine may trickle away, wetting the patient's clothes. Irritability of the viscus follows, leading to frequent attempts to pass water at short intervals during the day and night. The urine under these circumstances often becomes alkaline, and loaded with muco-pus and phosphates. As the obstruction increases, more and more residual urine is left in the bladder, which may in time form a tense, rounded, dull swelling in the hypogastrium. The amount of urine trickling away also increases, so that the patient's garments are always wet, giving him an unpleasant urinous odour. A certain amount of gleety discharge is present, whilst if the individual takes an excess of alcohol, or is exposed to wet and cold, complete retention may ensue. Sometimes the onset of symptoms is so insidious that such an attack of retention is the first marked feature in the case.

The **Pathological Conditions** arising from a stricture are best considered under the following five headings: (1) The *urethra anterior* to the stricture is usually in a perfectly normal state, although possibly the orifices of false passages may be seen. A few granulations are sometimes present, projecting at the commencement of the stricture. (2) The *stricture itself* is characterized by the development of fibro-cicatricial tissue immediately under the mucous membrane, and intimately adherent to it. It extends for a variable distance, and is often associated with a good deal of peri-urethral infiltration. (3) The *urethra behind the stricture* is dilated, and the mucous membrane velvety and friable; the orifices of the lacunæ and other glands are somewhat enlarged and more than usually evident, and perhaps ulceration may be present around them. In the later stages the inflammation may extend to the peri-urethral tissue owing to lymphatic absorption, or perhaps to the escape of a few drops of urine; a perineal abscess then results, leading subsequently to perineal fistulæ. When the obstruction becomes almost absolute, this portion of the urethra may give way, leading to extravasation of urine into the perineum and scrotum. (4) The *bladder* invariably manifests considerable changes in structure. At first the vesical wall undergoes a compensatory hypertrophy of its muscular elements and is thickened, in order to overcome the obstruction to the onward passage of urine. The lattice-work arrangement of the muscular bands becomes coarse, thickened, and evident, causing the vesical wall to assume a fasciculated appearance. As the pressure increases, the mucous membrane protrudes between the muscular fasciculi, giving rise to sacculation; it is also thickened and congested as a result of chronic cystitis, the superficial veins becoming varicose, and the surface perhaps ulcerated. The urine becomes alkaline and decomposes, perhaps containing muco-pus and phosphates. It is likely to stagnate in any sacculi which may exist, and may then determine the formation of phosphatic concretions; or the walls of the sacculi may become ulcerated, and after a time perforation and extravasation of urine into the cellular tissue may lead to a fatal issue. Occasionally the bladder, instead of being thickened, becomes dilated and atonic with very thin walls. (5) Consequent on the changes in the bladder, the condition already described as surgical kidney may develop as a result partly of the backward pressure, and partly from the extension of septic matter along the ureters to the pelvis of the kidney and calyces.

Physical Examination.—The actual diagnosis of a stricture can only be confirmed by a careful physical examination of the urethra, which is usually made by the introduction of a full-sized catheter or a solid bougie. A great variety of *catheters* is in use; in old days only metal instruments were obtainable, and even now the silver catheter is the favourite with many surgeons of eminence. In selecting such an instrument, care must be taken that it is suitably curved, and that the 'eye' is sufficiently large and bevelled inwards, so that no projecting rim lacerates the urethral mucous membrane. The great advantages of the metal instrument are that it is easily kept aseptic, and that the point can be located and thus guided more readily along the urethra. Of late years many different forms of flexible catheters have been introduced, and are now extensively employed, inasmuch as they give rise to less irritation than those made of metal. The objections to them are that the materials of which they consist are readily attacked and injured by antiseptics, whilst they are less easily directed through a stricture on account of their flexibility, it being impossible to know with certainty the situation of the point. Probably the best means of sterilizing a soft instrument is to expose it to the action of steam, which should be made to act not only on the exterior, but also inside the tube; many appliances to obtain this object have been devised. Amongst the best flexible instruments are the English or gum-elastic catheter, the French olive-headed or catheter-à-boule, and others made of silk-web coated with shellac, etc. Some varieties are now polished and prepared inside as well as out, and they should, if possible, always be selected. *Bougies* or solid instruments are preferred by some surgeons for the examination and treatment of strictures. Those known as Lister's bougies are the best, consisting of solid metal rods, curved like catheters, the bulbous ends of which are three sizes smaller than the shanks, thus enabling each instrument passed to prepare the way for the next. Flexible bougies are also made, whilst for finding a way through a tight and tortuous stricture a filiform or a long graduated whip-lash bougie, made of whalebone or catgut, may be employed; in the latter variety, the fine end is passed through the stricture, and coils up in the bladder, whilst the thicker portion is thus brought to bear on the stricture.

In order *to introduce a silver catheter or bougie*, the patient is laid on his back, the surgeon standing on his left side. The umbilicus should always be exposed, as also the upper parts of the thighs. The catheter, which has been previously sterilized, warmed, and covered with some antiseptic oil or grease, is taken in the right hand, and inserted into the urethra, with the handle directed over the left thigh and slightly downwards. The point of the instrument is guided as far as the perineum, and then the handle is carried round to the middle line of the body towards the umbilicus; it is then raised to the vertical, the penis being held in the left hand, and gently depressed between the patient's thighs, the so-called *tour-de-maître*. The catheter finds its way along the urethra into the bladder rather by its own weight than by any forcible action of the surgeon. The chief points at which difficulty may be experienced are: (*a*) The orifice, which may be small and contracted; (*b*) the lacuna magna, which is avoided by keeping the point of the instrument against the floor; and (*c*) the opening in the triangular ligament, which is best entered by keeping the point against the upper wall of the canal.

Some prefer to have the patient standing up, with the back resting against a wall or some firm support, the surgeon sitting in front, and manipulating, it is said, with greater accuracy. The objections to this position are: (*a*) The liability of the patient to faint, and (*b*) the existence of greater muscular tension than would obtain in the horizontal posture.

When a flexible instrument without a stilette is used, it is passed by pressing the point on with a little rotary movement until the bladder is reached, withdrawing a little, and pushing on again, if any obstruction is met. In some instances, however, the use of a stilette is absolutely necessary.

The chief **Dangers** of catheterism are as follows: 1. A considerable degree of *shock* is sometimes experienced, especially in sensitive individuals. It may be obviated to a large extent by first introducing about half a drachm of the 5 per cent. solution of cocaine into the urethra. 2. *Hæmorrhage* may be induced by laceration or abrasion of the mucous membrane, even though no false passage has been made; it is best avoided by gentleness, and the use of well-finished instruments. In spite of these precautions, when the mucous membrane is soft and congested, and in many cases of stricture, some bleeding cannot be avoided. It is rarely sufficient to call for special treatment, but if very abundant may be arrested, either by injections of hazeline, or iced boric acid lotion. 3. *False passages* are frequently produced in the treatment of strictures. The point of the instrument is most likely to leave the canal at some spot in the floor travelling for a variable distance, according to the force employed, under the mucous membrane between the urethra and rectum, occasionally re-entering the dilated urethra behind the stricture, which it avoids altogether, or perforating the posterior wall of the bladder by tunnelling under the prostate, an accident which can only occur in unskilful hands. The occurrence of a false passage is indicated by the sudden onward movement of the instrument, combined with pain and hæmorrhage; the point is usually deflected from the middle line, as is plainly seen by the obliquity of the rings at the end of the shaft; no urine comes unless the urinary passages are opened behind the stricture. On rectal examination, the instrument can be felt out of the middle line, and nearer the rectum than is normal, and in some exceptional cases has even been found in it. Slight false passages are not necessarily matters of great importance, but when extensive may lead to peri-urethral suppuration and extravasation of urine, possibly followed by fatal results. 4. Inflammatory phenomena may be lighted up in the prostate, and acute epididymitis induced by extension along the vas deferens; these are almost always due to sepsis. 5. Where the kidneys are diseased, owing to an old-standing stricture, *urethral fever* not uncommonly follows the introduction of a catheter, and is characterized by the occurrence of a rigor, the temperature perhaps reaching 105° or 106° F. The patient under these circumstances must be put to bed and kept warm, plenty of warm demulcent drinks being given, and perhaps a pill containing quinine and opium; in the worst cases, suppression of urine follows (*vide* Surgical Kidney, p. 994).

In examining a patient for a suspected stricture, a full-sized catheter or bougie, *e.g.*, No. 9 or 10 (English), should invariably be first used, so as to ascertain where the obstruction is situated. If this cannot be passed, smaller instruments, and even filiform bougies, are inserted until one is found which will enter the bladder; failing this, other treatment must be adopted.

The **Treatment of Passable Strictures** is conducted either by dilatation or a cutting operation (internal or external urethrotomy).

Treatment by **Dilatation** is effected in various ways, according to the nature of the stricture and the urgency of the symptoms. Where the obstruction is not serious, and an instrument can be easily passed, *gradual dilatation* should always be employed; this consists in the use of instruments once or twice a week, steadily increasing the size until a No. 12 is reached. If the intervals are too short, the urethra may become irritated, spasm induced, and the lumen of the canal temporarily diminished in size; by keeping the patient quiet for a few days on a bland diet, and the bowels well open, the spasm disappears. In cases where time is an object, *rapid dilatation* may be undertaken by the passage of several sizes of bougie at one sitting; for this purpose, Lister's instruments are particularly useful. Where only a very small catheter can be introduced, and that with difficulty, *continuous dilatation* may be adopted by keeping the patient in bed, tying in the small instrument for forty-eight hours or more, at the expiration of which period a catheter several sizes larger can be substituted. This in turn may be tied in if the patient can bear it; but the presence of a catheter within the urethra for any length of time is not always tolerated, and may give rise at the end of two or three days to considerable constitutional disturbance and urethral fever. *Forcible dilatation* is a plan which has now but few advocates. It consists in the passage of an instrument, the shaft of which is made in two portions, which can be separated from one another in such a way as to destroy the stricture either by distension or rupture of its substance. It is but little used, on account of the great tendency to the formation of an even more intractable stricture than before, when cicatrization is complete.

By whichever of these methods dilatation is accomplished, it is essential that either the surgeon or the patient should pass an instrument through the stricture at first every week or two, and subsequently at longer intervals, to overcome the tendency to re-contraction which is ever present.

The **Treatment of Passable Stricture** by a **Cutting Operation** is conducted either by internal or external urethrotomy.

Internal Urethrotomy is a valuable means of treatment when rightly employed, but in careless or inexperienced hands may be attended with considerable danger. It has been performed either by passing an instrument through the stricture, and dividing it from behind forwards, or by passing an instrument down to the stricture, and dividing it from before backwards. The latter plan of treatment, though recommended by some skilled authorities, is not an operation which commends itself to our judgment, inasmuch as it is almost impossible to gauge the amount of tissue divided. The former plan of incising a stricture from behind forwards is of course only called for under special circumstances, since if the urethrotome can be passed through a stricture, ordinary dilatation is in the majority of cases practicable. It is useful, however, (*a*) in the treatment of very old and dense cartilaginous strictures, as also (*b*) for resilient strictures, and (*c*) for patients with excessively irritable urethræ. It should only be employed when the obstruction is situated in the anterior two-thirds of the urethra. Many forms of urethrotome have been devised, but perhaps the most useful is that known as Civiale's, which can only be used for a stricture which will admit of the passage of a No. 5 catheter. The end is bulbous, and contains a hidden knife, worked by means of a button in the handle. The instrument is passed through the stricture, the cutting blade projected, and by withdrawing it the cicatricial tissue is notched to such an extent as to allow a full-sized catheter to be inserted at once, and, if possible, tied in. Care must be taken not to cut beyond the limits of the cicatricial tissue, otherwise hæmorrhage, peri-urethral suppuration, or even extravasation of urine, may ensue. It is also advisable to sterilize the urethra as far as possible by washing it out with weak antiseptic solutions before operating.

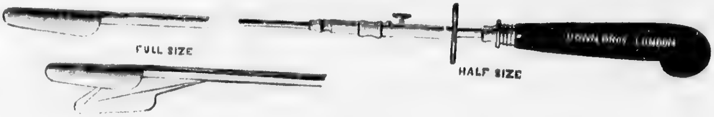


FIG. 356.—CIVIALE'S URETHROTOME. (DOWN BROTHERS.)

External Urethrotomy, or **Syme's Operation**, is required under circumstances similar to those needing internal urethrotomy, if the stricture is situated in the posterior third of the urethra, but is chiefly employed where perineal fistulæ are present. It is performed by passing a special shouldered staff (Syme's, Fig. 357), the distal end of which is small enough to pass through the stricture, and grooved in the middle line, whilst the shaft of the instrument is of larger size, and ends abruptly, so that the shoulder rests against the face of the stricture; the groove extends on to the larger portion for about ¼ inch. The patient is then placed in the lithotomy position, and the surgeon, seated opposite the perineum, which is shaved and well purified, incises it in the middle line, carrying his dissection carefully downwards so as to reach the groove in the staff behind the stricture. The knife is then carried forwards to the anterior extremity of the groove, and inasmuch as it extends on to the shaft of the instrument, the stricture is completely divided. Any fistulæ which exist are laid open into the median wound, and thoroughly scraped and purified. A full-sized soft catheter is then passed into the bladder, through either the penis or the perineum, according to circumstances, and retained in position for some days, the urine thus being syphoned off in the usual way, whilst the perineal wound, after all hæmorrhage has been stopped, is packed with strips of antiseptic gauze, and allowed to heal by granulation. The catheter is removed early or late according to the amount of general disturbance caused thereby, and subsequently a full-sized instrument can be passed into the bladder daily. Some surgeons have recommended the use of the so-called self-retaining catheters, in the hope of preventing urine from finding its way through the external wound; several varieties have been suggested, but they are of little practical value, since the escape of urine along the side of the instrument can never be totally prevented.

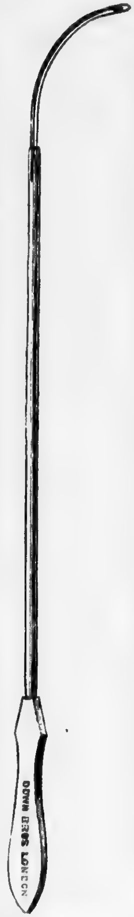


FIG. 357.—SYME'S SHOULDERED STAFF FOR EXTERNAL URETHROTOMY. (DOWN BROTHERS.)

The **Treatment of Impassable Stricture** varies according to whether or not the condition is complicated with retention of urine.

If *no retention is present*, it is possible that the inability to pass an instrument is due to some temporary spasm or congestion induced by errors of diet or drink, or perhaps by exposure to cold. Hence the patient should rest in bed for a few days, his bowels be well opened, the diet regulated, and a mixture containing some alkaline purge and tincture of henbane administered. Further attempts at instrumentation should then be made, if necessary, under an anæsthetic, and if the stricture still remains impassable, *Wheelhouse's operation* is indicated. This consists in opening the urethra in front of the constriction, tracing the passage backwards, and dividing it. A Wheelhouse's straight staff with a median groove and a blunt hook at the end is inserted down to the stricture, and the urethra opened just in front of it by cutting down on the groove. The staff is then twisted round, the upper end of the incision drawn up by the projection of the hook, and the sides of the urethra held apart with artery forceps. The orifice of the stricture is thus exposed, and granulations may often be seen projecting from it. A fine probe-pointed director can generally be insinuated along the urethra through the stricture, which is then divided. A full-sized instrument is passed into the bladder and retained for a few days, whilst the wound is allowed to heal by granulation.

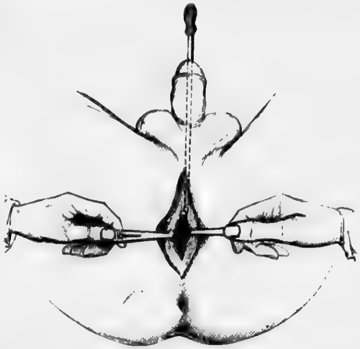


FIG. 358.—WHEELHOUSE'S OPERATION FOR IMPASSABLE STRICTURE. (BRYANT'S 'SURGERY.')

If *retention of urine is present* in a case of impassable stricture, no time must be lost. If the case is seen at an early stage, and the symptoms are not urgent, the patient may be given a hot bath, and the bowels opened by a warm enema, whilst a moderate dose of opium or preferably a morphia suppository is administered. If the urine is not passed naturally in the bath, and the bladder is becoming distended, being felt in the lower part of the abdomen, suprapubic aspiration, or puncture with a trocar and cannula, should be undertaken, and temporary relief thus obtained. Probably, when tension has been removed from the posterior part of the urethra, a catheter will be introduced without much difficulty. Failing this, aspiration may be several times resorted to, but it is generally wiser to open the urethra behind the stricture, and drain the bladder, since the risks of septic troubles, extravasation of urine, dangerous pressure upon the kidneys, and urinary infiltration along the lines of puncture, are thereby lessened.

Cock's Operation, or **Perineal Section**, is sometimes adopted when no guide can be passed into the bladder. The patient is placed in the lithotomy position, and the situation of the membranous urethra ascertained by inserting the index-finger into the rectum. A median perineal incision is then made, and after dividing the cutaneous structures, the surgeon plunges the scalpel boldly inwards towards the apex of the prostate, guided by his finger in the rectum. He must keep strictly in the middle line, so as to avoid the important vascular and other structures which are so abundantly present in the perineum. As soon as the urethra is opened, a gush of urine often escapes; the upper urethral wall should not be damaged with the knife, for fear of opening up the deep pelvic cellular tissue.

This operation may be tolerably simple if the urethra behind the stricture is dilated, as is not uncommonly the case; but sometimes it is extremely difficult, especially if the urethra has been displaced laterally. If the stricture is not situated too far from the incision, it is always wise to complete the operation by dividing it, and a full-sized catheter can then be passed into the bladder, and the perineal wound allowed to granulate. If the stricture cannot be dealt with during the operation, and is of a dense cartilaginous nature, a tube is inserted into the bladder through the perineum; probably at the end of a few days the tissue will yield sufficiently to allow of the passage of a catheter, or Wheelhouse's operation can be subsequently adopted.

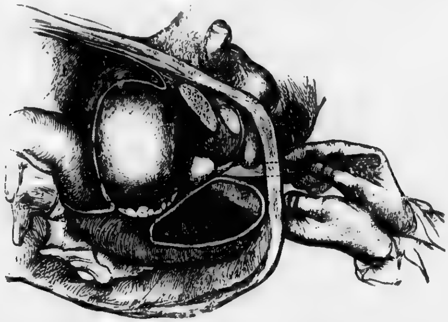


FIG. 359.- -COCK'S OPERATION OF PERINEAL SECTION. (BRYANT'S 'SURGERY.')

The chief **complications** of stricture other than those already mentioned are perineal abscess, perineal fistula, and extravasation of urine.

A **Perineal Abscess** consists in a focus of peri-urethral suppuration, which is due either to a limited extravasation of urine, or to the absorption of septic material through an ulcerated surface.

It is evidenced by the formation of a hard brawny swelling in the perineum, which is tender to the touch. As it approaches the surface, fluctuation can be detected, and the skin over it becomes congested and œdematous. Constitutional disturbance and fever of an asthenic type are also present. Left to itself, it bursts and usually gives rise to a perineal sinus or fistula, discharging either pus, or urine mixed with pus. One or many of these fistulæ may occur (Fig. 360), and the openings are not limited to the perineum, but may also be found in the thighs, buttocks, or even the groins. In chronic cases, the scrotal or perineal tissues become infiltrated, and of an almost cartilaginous consistency.

Diagnosis.—Every abscess in the scrotum or perineum is not necessarily associated with stricture, for simple irritation of the skin may lead to a superficial abscess; suppuration in the lacunæ, or Cowper's glands, may result from gonorrhœa; a prostatic or ischio-rectal abscess may point in the perineum; whilst the injury inflicted by the passage of instruments, or the existence of false passages, may lead to a similar result.

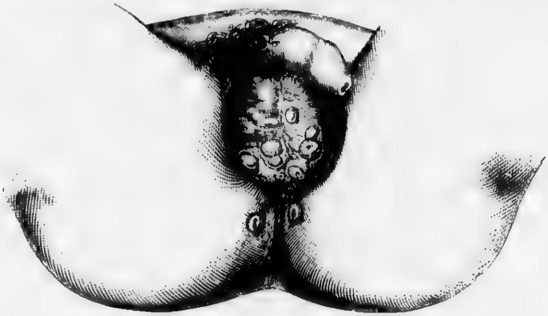


FIG. 360.—PERINEAL FISTULÆ. (BRYANT'S 'SURGERY.')

The **Treatment of a Perineal Abscess** consists in the application of hot fomentations during the early stages; as soon as pus is present, it should be evacuated through a free incision, and it is often advisable to take the opportunity of dealing radically with the stricture by section at the same time. Perineal fistulæ can rarely be cured without operation, since, although the stricture may be completely dilated, the discharge of urine and pus continues. Under these circumstances Syme's or Wheelhouse's operation is the proper treatment.

Extravasation of Urine is a condition due to solution of continuity of the urethral walls, allowing the urine to find its way into the perineal and scrotal tissues. It usually results from overdistension of the urethra behind a neglected stricture; during some violent effort at micturition, the patient experiences severe pain, and a sensation as if something had given way in the perineum, followed by a feeling of relief. This, however, is of short duration, as it is soon succeeded by the local and constitutional effects of extravasation. The same phenomena are produced in cases of traumatic laceration of the urethra if the patient attempts to empty his bladder. Occasionally the onset of symptoms is more gradual, being preceded by a peri-urethral abscess, which bursts into the urethra; at each act of micturition the cavity becomes distended with urine; finally the wall yields, resulting in diffuse extravasation.

The membranous urethra is almost always the site of the rupture, the urine finding its way subsequently through the anterior layer of the triangular ligament, and being guided towards the anterior abdominal wall by the arrangement of the fasciæ. The root of the penis, covered by its appropriate muscles, lies in an interfascial cul-de-sac, formed by the anterior layer of the triangular ligament above, and the deep layer of the perineal fascia (or fascia of Colles) below; these two layers are continuous, passing round the transversus perinei muscles, and are both attached laterally to the ischio-pubic rami. Into this space the urine finds its way after the anterior layer of the triangular ligament has yielded, and owing to the fact that its passage backwards and laterally is checked by the attachment of the fasciæ, it is necessarily forced forwards, infiltrating in order the perineum, scrotum, and body of the penis. If more extensive, it travels along the spermatic cords to the anterior abdominal parietes, its passage downwards into the thighs being prevented by the attachment of the deep layer of the superficial fascia of the abdomen to the fascia lata just below Poupart's ligament. In the most severe cases the urine may even find its way as far as the axillæ.

Scarpa's

The **Effects** of extravasation of urine are always serious. Possibly, if the urine were pure and aseptic, part of it might be absorbed; but in cases of stricture it is almost certain to be foul and alkaline, and hence wherever it travels it gives rise to a gangrenous cellulitis. The parts at first become infiltrated and brawny, but soon emphysematous crackling and putrefaction are observed, owing to necrosis of the cellular tissue. The congested and œdematous skin turns to a dusky purple or black colour, and finally gives way or separates, allowing exit to a mixture of pus, urine, and decomposing slough of a most offensive and penetrating odour. The superficial loss of substance may be so extensive as to lay bare both testicles, and even the body of the penis, or part of the anterior abdominal wall. The inflammatory process is necessarily associated with severe constitutional disturbance, at first characterised by high fever and a quick, bounding pulse; but later on the temperature may become subnormal, and the patient profoundly collapsed from toxæmia.

The **Treatment** consists in early and free incisions, so as to give exit to the urine and pus, and to prevent, if possible, the sloughing of the skin and subcutaneous tissues. Every part that the urine has infiltrated must be dealt with in this way; thus, the perineum should be incised in the middle line; the scrotum similarly divided, if need be, down to the urethra, the testicles being laid on either side; the penis should be incised, if necessary, on either side of the urethra, and along the dorsal surface. It is often possible to expel a large portion of the urine by firmly squeezing the infiltrated tissues. A full-sized catheter must be passed into the bladder, and to effect this the urethra has often to be laid open and the stricture divided; perineal drainage is always preferable for these cases. The parts should be subsequently dusted over with iodoform, and dressed with warm antiseptic applications, *e.g.*, a charcoal or carbolic linseed poultice, or boracic fomentations. Frequent hip-baths should be employed, and, if practicable, a continuous sitz-bath would be the very best means of treating the case. As soon as the wounds become clean, they should be dressed in the ordinary way to allow them to granulate. The general health of the patient must of course be attended to, plenty of easily assimilated nourishment, stimulants, and quinine being administered.

Urinary Fistulæ are most commonly found in the perineum, scrotum, or body of the penis. They usually result from periurethral suppuration in connection with a stricture, but are occasionally due to other causes, *e.g.*, a lacunar abscess after gonorrhœa, or a prostatic abscess. They vary much in size and number; when the result of a stricture, many may be present, and great infiltration of the surrounding tissues is usually produced. The **Treatment** of perineal fistulæ has been already in measure described, external urethrotomy being necessary if a stricture exists. Occasionally the perineal wound does not close after such an operation, even when the stricture has been divided; the edges of the fistula should then be pared, and the wound brought together by deep quilled sutures. A catheter should be kept in the bladder for a few days, and the urine regularly drawn off after its removal.

When of small size, and situated either in the perineum or the penis, cure may be determined by cauterizing the passage either with a probe coated with nitrate of silver or by a galvano-cautery, but in other cases some form of urethroplasty is necessary (p. 1096).

Affections of the Penis.

Phimosis, when complete, is a condition in which the prepuce is so long, and the orifice so narrow, that it cannot be retracted behind the corona. It is usually **Congenital** in origin, and may exist to such a degree as to render micturition impossible. More frequently the opening is a very small one (pinhole prepuce), permitting micturition, but leading to irritability of the bladder from the obstruction. In such cases the prepuce is usually adherent to the glans, and considerable irritation is caused by the retention of the smegma secreted by Tyson's glands; this may collect and become inspissated so as to give rise to definite concretions. The child pulls at the foreskin, owing to the itching produced, and thus the symptoms of vesical calculus may be simulated. Attacks of balanitis are also frequent, and should the prepuce be withdrawn, paraphimosis is almost certain to follow. If allowed to remain untreated long enough, distension of the bladder, and even hydronephrosis, may supervene. Not only is this condition in itself a cause of irritation and even danger to the individuals affected, but it is often provocative of masturbation, whilst it tends to aggravate the symptoms of venereal disease, and there is but little doubt that it acts as a predisposing cause to epithelioma of the penis. Phimosis also occurs as an **Acquired** condition, resulting from the cicatrization of venereal sores.

The **Treatment** of phimosis consists in circumcision. Other methods have been suggested—*e.g.*, dilatation of the prepuce, and merely slitting it up—but they are not satisfactory.

Circumcision should always be performed on children with a long prepuce within the first year of life, since at that time the parts are but slightly developed, the operation is a trifling one, and but little inconvenience is subsequently experienced; the longer it is postponed, the more troublesome does it become. The best method of operating is as follows: The dorsal aspect of the prepuce is put on the stretch by grasping it on one side of the median line with a pair of catch forceps; a director is then introduced between it and the glans, and held exactly in the middle line, and the prepuce slit up with a curved pointed bistoury or scissors. The lateral halves are now separated from the glans, adhesions, if necessary, being broken down; this must be very thoroughly attended to, so as to enable all retained smegma to be removed, and the corona glandis defined. The redundant preputial tissue, both skin and mucous membrane, is cut away on each side by scissors, special attention being directed to the removal of sufficient tissue on the under side, to prevent the unsightly projection so frequently seen just below the frænum. In adults several vessels will bleed and require to be ligatured, especially that in the frænum, but in a child the hæmorrhage is trifling. Having carefully trimmed up the edges, and snipped off all ragged corners so as to render the margins of the wound regular, catgut sutures are inserted so as to prevent any raw surface being exposed; in children only a few are required, but possibly a considerable number in adults; a continuous suture should never be employed. The wound is dressed with strips of gauze or lint dipped in carbolic oil, and round this, again, a wisp of antiseptic wool; no bandage or tape is required.

In adults considerable after-trouble may be experienced from nocturnal erections, which may be so marked and prolonged as to tear through the stitches; to control this the patient's bowels should be freely opened, and he should be kept on a low and unstimulating diet, and bromide of potassium or other sedatives administered. The stitches are usually removed at the end of five days, and the parts are then dusted over with a mixture of powdered boric acid, zinc oxide, and starch, so as to reduce their sensitiveness.

When a phimosed prepuce is completely retracted, the patient often finds it impossible to replace it, thus giving rise to a condition known as **Paraphimosis**. It is due to the narrow orifice of the prepuce getting behind the corona, and is characterized by great œdema and congestion, not only of the exposed mucous membrane, but also of the glans itself. If left untreated, ulceration takes place along the line of constriction, and the parts become fixed in their deformed position, the vessels sooner or later accommodating themselves to the new conditions, and the œdema slowly disappearing. In some cases sloughing of the glans may occur.

Treatment consists in forcible replacement of the prepuce. This is accomplished by grasping the penis between the first and second finger of each hand, and compressing the glans penis with the thumbs so as to empty the vessels and diminish the amount of œdema present, and thus reduce its size (Fig. 361). At the same time the fingers draw the prepuce forwards, and thus finally reposition is effected. When the œdema of the prepuce is very marked, it should be punctured in several places to allow the escape of serum, and diminish the tension previous to reduction as just described. In more advanced cases reposition becomes impossible, and then the narrow constricting band caused by the orifice of the prepuce must be divided on the dorsal aspect. This will free the parts, which can be subsequently drawn forwards, and after the œdema has been reduced by applying lotio plumbi for a few days, circumcision may be advantageously undertaken.

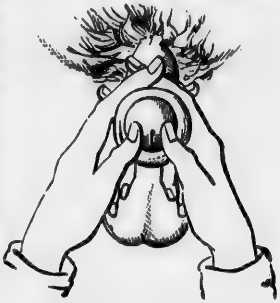


FIG. 361.—REDUCTION OF PARAPHIMOSIS.

Balanitis, or inflammation of the prepuce, arises either as a simple inflammation from want of cleanliness with a long foreskin, or more frequently as an accompaniment of gonorrhœa or soft chancres.

It is characterized by swelling and œdema of the prepuce, and a muco-purulent or purulent discharge. If the surface of the glans is also involved, the term **Balano-posthitis** is sometimes applied to it. Occasionally, when a considerable degree of phimosis exists, the under surface of the prepuce may become ulcerated, and even perforated; whilst in very neglected cases, and especially if phagedena is present, the prepuce will slough, and allow the glans to protrude, usually through its upper surface.

Treatment.—In simple cases, all that is required is to thoroughly cleanse the parts by washing beneath the foreskin, and then apply lead lotion on lint between the glans and the prepuce; but when there is much discharge, and the foreskin long and swollen, or if perforation is threatening, the prepuce must be slit up, and, after the parts have been restored to a healthy state, the redundant tissues should be cut away by a modified circumcision.

Herpes not uncommonly affects the prepuce and glans. It may occur as a result of simple local irritation, more especially in gouty individuals; but it is most frequently seen in patients who have suffered from syphilis, and is then likely to be somewhat intractable. It manifests itself as a crop of small vesicles on a hyperæmic base, which become abraded, leaving a number of small ulcers. It is preceded by pain of a neuralgic type, and accompanied by much itching and irritation. All the treatment needed is to keep the parts clean, and to dust them over with powdered oxide of zinc and starch. In the majority of cases, the disease lasts from a week to ten days. During the healing of the herpetic ulcers, a patient is very liable to be inoculated with the virus of either the soft chancre or syphilis if he exposes himself to the risk of infection.

Warts often arise on the penis in the shape of red, vascular excrescences, usually pedunculated, and sometimes of considerable size. They are met with most frequently as a sequela of gonorrhœa, and must be carefully distinguished from mucous tubercles. They should be treated by snipping them away with scissors, and cauterizing the base with a galvano-cautery.

Horns are also occasionally seen arising from the body of the penis. They are of the usual sebaceous type, as described at p. 168, and should be excised.

Epithelioma of the penis rarely arises except in patients who are the subject of congenital phimosis or long foreskins, and hence it is stated that the disease is unknown amongst the Jews. It usually commences in the sulcus behind the corona glandis, and rapidly spreads to the surrounding parts, manifesting itself either as an irregular, papillated, wart-like outgrowth, or as a diffuse infiltration, ulcerating early, and leading to considerable destruction of tissue. At first the tumour is mainly beneath the prepuce, which becomes distended, producing a sanious discharge; but as the case progresses, the prepuce itself is attacked, and even perforated. Later on the body of the penis is invaded, and, owing to its great vascularity, the disease makes rapid progress. The inguinal glands are early affected, but when the body of the penis is involved, the lumbar glands are also implicated.

The **Diagnosis** of epithelioma from warts is easily made by contrasting the infiltration of the base produced by the former with the lax and normal condition of the glans in the latter condition.

The **Treatment** of epithelioma consists in amputation of the penis whenever the disease is sufficiently limited to lead to the hope that it can be eradicated. When confined to the distal end of the organ, the operation may be performed through the body; but when this is impracticable, owing to the extent of the growth, the whole penis must be removed.

Amputation through the body of the penis is an operation of but little difficulty. A short flap is reflected from the dorsum, and the corpora cavernosa cut through, the urethra and remaining portions of the organ being removed at a lower level. Bleeding is then arrested by securing the divided vessels; five ligatures are usually required, viz., one for the artery to the corpus cavernosum on either side, one for each dorsal artery, and one for the artery to the septum. The urethra is then isolated, and passed through an opening made in the upper integumental flap. It is split along its upper wall, and secured by sutures to the margins of the opening, so as to prevent subsequent retraction; the flaps are then united by stitches.

Amputation of the whole penis is a much more serious proceeding. The patient is placed in the lithotomy position, and the perineum, after being shaved and purified, incised freely in the middle line. The corpus spongiosum is traced backwards, and divided at such a level as to allow the mucous membrane lining the proximal portion of the urethra to be stitched to the skin at the posterior angle of the incision. The corpora cavernosa are freed from their connections, and separated at their origins from the ischio-pubic rami by suitable raspatories. An elliptical incision is then made round the root of the penis, the dorsal vessels are divided and secured, and the suspensory ligament cut through. The penis can then be drawn forwards, and by a few final touches of the knife completely removed. All bleeding points are ligatured, and the anterior wound closed by a continuous suture in the middle line, a drainage-tube being placed in the perineal portion for a few days. The results of this operation have, on the whole, been very satisfactory, although the patient has to assume the sitting posture in order to micturate.

APPENDIX.

With regard to the surgical affections of the female genital organs, it is not our intention to do more than briefly refer to a few of those affecting the region of the vulva and labia.

Vulvitis, or inflammation of the lining membrane of the vestibule, is due to gonorrhœa or to any irritating discharges coming from above. It is characterized by infection of the mucous membrane, by itching or smarting pain, especially on walking, and a secretion of mucus or muco-pus, causing the labia to stick together. The mucous follicles may become affected, and a localized abscess result, situated either immediately beneath the mucous membrane or in the substance of the labium. The *treatment* consists in the use of warm and mild antiseptic lotions to purify the part, sitting in hot water being most beneficial. At the same time the patient is kept quiet, and the bowels opened by a saline purge. When a follicular abscess forms, it should be incised through the mucous membrane and its cavity stuffed with a small portion of dressing. A labial abscess should be freely opened at any spot where it is tending to point, and the cavity packed with gauze to ensure healing from the bottom.

Cysts of the Labia are occasionally seen, being due to the blocking of the duct of a mucous follicle, or of the more specialized vulvo-vaginal glands (glands of Bartholin); they may attain considerable dimensions and must be freely dissected out.

Hæmatoma of the vulva may be due to traumatism, *e.g.*, a kick or fall, or to rupture of a varicose vein, especially during parturition. The labium is much swollen and firm to the touch, owing to the coagulation of the blood; suppuration occasionally follows, especially if due to injury associated with a superficial abrasion. *Treatment.*—If the swelling persists, or if suppuration ensues, an incision should be made and the blood evacuated; the cavity is then stuffed, but of course the most thorough antiseptic precautions must be adopted.

Another occasional result of traumatism is **laceration of the recto-vaginal septum**, which may be caused by kicks, or by falling on a stick or paling. The wound is usually contused, and the margins irregular, so that immediate suture is scarcely likely to succeed. The parts are, therefore, kept clean by frequent douches and allowed to granulate, and the loss of substance is in that way often repaired. Should a fistula persist, a plastic operation will be subsequently necessary.

CHAPTER XXXVII.

AFFECTIONS OF THE TESTIS, CORD, SCROTUM AND SEMINAL VESICLES.

Congenital Affections of the Testis.

It is scarcely necessary to state that the testicles are not developed in the scrotum, but from the posterior wall of the abdominal cavity, so that they lie at first behind the peritoneum close to the kidneys, and may even have a mesentery developed, known as the mesorchium. The body of the gland arises from the so-called genital ridge, which is covered by columnar epithelial cells, and lies to the mesial side of the Wolffian body. The vasa efferentia are developed from the tubules of the latter structure, coming into relation at a later date with the seminal tubules, whilst the vas deferens is formed by the Wolffian duct.

Occasionally the body of the testis is entirely absent, whilst a few cases are on record of absence or deficiency of the vas. Very rarely two testicles have been developed on one side, and have both found their way into the scrotum (*polyorchism*).

The passage of the testis from the abdominal cavity to the scrotum takes place at about the end of the eighth month of intra-uterine life. 'The gubernaculum testis is the active agent in bringing about the descent of the testis. This is a band of involuntary muscular fibres which traverses the inguinal canal, and establishes important connections both within and without the abdominal cavity. Below, three main attachments of the gubernaculum may be recognised, viz., (*a*) to the abdominal wall; (*b*) to the pubis; (*c*) to the bottom of the scrotum. Above, the gubernacular fibres are chiefly connected with the testicle; but many of them are also attached to the peritoneum on the posterior wall of the abdomen. By the traction which the gubernaculum exerts on the testicle the descent of that organ is brought about. By the portion attached to the abdominal wall the testicle is pulled down to the internal abdominal ring, the pubic portion drags it through the inguinal canal, whilst the scrotal part finally leads it into the scrotum.

'The formation of the processus vaginalis is accounted for in the same way. Some of those gubernacular fibres which are inserted into the peritoneum drag down the peritoneal diverticulum which lines the inguinal canal and scrotum, and prepares the way for the testicle' (Cunningham's 'Manual of Anatomy,' vol. i., pp. 426, 427).

Two chief forms of malposition of the testis are described, arising either from its incomplete or abnormal descent.

1. **Incomplete Descent or Retention of the Testis.**—The testis may either remain in the abdominal cavity attached to the abdominal wall by a mesorchium (*retentio abdominalis*); or, more frequently, it remains just within the internal abdominal ring (*retentio iliaca*); whilst most commonly it occupies the inguinal canal, or lies just outside of it (*retentio inguinalis*). The organ in the

latter position is freely mobile, being readily pressed up towards the abdominal cavity. The **Causes** of this condition must be looked for mainly in some abnormal attachment of the gubernaculum, or possibly in the existence of intra-uterine peritonitis. Less commonly a contracted condition of the external abdominal ring, or an unduly large epididymis, may determine its occurrence.

The condition is easily recognised by the absence of the testicle in the scrotum, whilst in the inguinal variety the organ can usually be detected as a small moveable swelling about the size of a horse-bean, giving the characteristic testicular sensation on pressure. The scrotum on the affected side is imperfectly developed.

In any of these varieties a late descent of the testis may occur, usually accompanied by a congenital hernia.

2. **Malposition of the Testis.**—Two distinct forms are described: (*a*) *Ectopia Perinealis.*—In this variety the testis finds its way into the perineum, slipping along the groove between the thigh and the scrotum. It may exist as a congenital condition, being then due to the contraction of an accessory band of gubernacular fibres: or it may happen in consequence of a late descent of the testicle, owing to atrophy of the scrotum. It always causes considerable inconvenience to the patient, especially on sitting or riding. (*b*) *Ectopia Cruralis.*—The testicle here lies on the inner side of Scarpa's triangle, usually in the region of the saphenous opening. It is stated to escape along the crural canal, but more probably it passes down the inguinal canal as usual, and then finds its way over Poupart's ligament to this situation, guided by a second accessory band of gubernacular tissue. When, as not uncommonly happens, a congenital hernia also exists, it may travel outwards to the anterior superior spine, being directed there by the arrangement of the fasciæ, as in a femoral hernia (extraparietal interstitial hernia, p. 914).

In all cases of retained or misplaced testis the organ is atrophic, and probably functionally useless. At first it is normal in texture, but as a result of frequently repeated injury and inflammation it is likely to undergo degenerative changes. If only one organ is affected, but little harm results; but if both are involved, the individual will probably be sterile.

Complications of a Retained or Misplaced Testicle.—Any of the conditions to be described hereafter in this chapter may involve a retained or misplaced testicle, just as if it were in the scrotum, and give rise to considerable trouble, especially when the organ is retained in close proximity to the peritoneum, peritonitis being thus induced. A testis, misplaced or retained in the inguinal canal, is much exposed to injury, and a subacute traumatic orchitis often occurs; it is a well-known fact that such organs are very prone to become the seat of malignant disease at a later period of life.

Treatment.—Taking into consideration the discomfort occasioned by this condition, as well as the risk arising from the tendency to malignant disease, there can be little doubt that the best method of treatment is the removal of the testicle. Many operations have been devised with the idea of placing the organ in its normal position in the scrotum, but the majority of such methods have proved useless, owing to the traction required and the defective length of the spermatic vessels and cord.

Another condition met with congenitally is **Inversion** of the testis, the epididymis lying in front, and the body of the testis behind. It is of no clinical significance, except that in careless hands the organ may be injured whilst tapping a hydrocele.

Torsion of the Spermatic Cord, resulting in acute strangulation of the testis, has attracted considerable attention of late years. The cause still remains unknown, but several of the cases recorded have been associated with late descent of the testicle, and others have been attributed to twists and strains. The symptoms are tolerably characteristic: the patient complains of an acute sickening pain in the testis which persists until gangrene has supervened, and may then disappear; it is accompanied by a certain amount of pyrexia, and the appearance of a tumour, either in the inguinal region or in the scrotum. The testicle, slightly enlarged, is felt below, and above it a larger mass, consisting of the twisted cord and the congested and swollen epididymis. In some cases the latter swelling has been crepitant, owing to the development of gases due to its putrefaction. The condition is very likely to be mistaken for a strangulated hernia, which it closely resembles; but the presence of fever, and the absence of abdominal distension and of fæcal vomiting, are important distinctive signs; moreover, constipation, though often present, is never absolute. If the testis is situated in the scrotum, the cord and inguinal canal are found to be clear; whilst if situated in the canal, the affected side of the scrotum is empty. The only **Treatment** possible is exploration and removal of the inflamed or gangrenous testis and cord, unless the case is seen very early, when it may be possible to untwist it.

Injuries of the Testis and Cord.

Contusion of the Testis is a very common form of injury. It arises from blows, kicks, squeezes, and the like, and is always associated with immediate pain of a most sickening and intense character, which is not only experienced in the testicle, but also radiates along the cord towards the loins and back, and down the front of the thigh. Severe shock accompanies the pain, and may be so profound as to lead to a fatal issue. A well-marked traumatic orchitis often follows, and this may in turn induce atrophy of the organ, although the same result may occasionally occur without much evidence of inflammation, being then possibly due to thrombosis and occlusion of the spermatic vessels. A hæmatocele is also induced by a subcutaneous lesion of this nature. **Treatment** consists in keeping the patient in the recumbent posture with the scrotum well raised, and in applying hot fomentations or evaporating lotion.

Penetrating Wounds or **Punctures** are uncommon except as a result of surgical treatment (*e.g.*, tapping a hydrocele). A certain amount of hæmorrhage usually follows, whilst the immediate lesion is associated with severe testicular pain. If the wound becomes septic, the tubules are likely to protrude, and a hernia testis may result. All that is ordinarily required is to purify the parts and allow them to heal; sutures should not be inserted into the tunica albuginea. If the gland is totally disorganized, as by a gunshot wound, castration must be undertaken.

Hæmatocele, or a localized collection of blood in the tunica vaginalis or cord, is a common result of injuries.

1. **Hæmatocele of the Tunica Vaginalis** arises from traumatism, such as a sudden blow or severe strain, and occasionally follows the tapping of a hydrocele if a superficial vessel has been ruptured or punctured, or if the body of the testis has been wounded; it may, however, be due to general oozing from dilated capillaries in the serous membrane owing to the sudden relief of tension. It also occurs more or less spontaneously in connection with malignant disease. The **History** generally given is that the patient was seized with a sudden sickening pain in the testicle,

which became quickly enlarged without any evidence of inflammation. If blood is extravasated at the same time into the scrotum, the integument becomes discoloured in the course of a few days owing to a diffusion of the blood pigment. At first the swelling is smooth and fluctuating, exactly resembling a hydrocele, except in the absence of translucency; but owing to a deposit of fibrin on the walls from the coagulation of the blood, it in a short time becomes hard and firm, closely simulating a solid tumour. In slight cases the blood is entirely absorbed, but when the effusion is considerable the coagulum is likely to persist. On laying open such a swelling, the testicle is usually found in a healthy state, whilst the enlarged tunica is occupied by some blood-stained brownish-yellow fluid, and surrounded by a mass of fibrinous coagulum, part of which is deposited in laminæ upon the walls, and part remains as shreddy masses projecting into its lumen. In very chronic cases the walls of the tunica become thick and indurated, and may even undergo calcareous changes. Suppuration of a hæmatocele is sometimes met with as a result of auto-infection. The **Diagnosis** of a hæmatocele in the earlier stages is easily made; but when it has solidified it can only be suspected by the history, and by the exclusion of other sources of enlargement, whilst an exploratory incision or puncture is often necessary to settle the diagnosis. **Treatment.**—When the patient is seen soon after the injury, he must be kept at rest, the parts elevated, and evaporating lotions applied; whilst if the effusion is large, removal of a portion by aseptic tapping will expedite the process of absorption. In more chronic cases it may be necessary to lay the cavity open and remove its contents, whilst in the later stages, if the tunica has become thick and indurated and the testis atrophied, castration may be advisable.

2. **Hæmatocele of the Cord** is but rarely seen. It is due to the rupture of one of its vessels, as a result of injury or strain. A swelling of considerable size rapidly forms, extending along the cord from the inguinal region to the scrotum, but the testis remains free and unimplicated. Such a condition is very likely to be mistaken for an omental hernia, but on careful examination the tumour will be felt to be more uniform in consistency, more rounded in outline, and even semi-fluctuating. It is always irreducible, whilst the history of the case will assist the surgeon in making a correct diagnosis. **Treatment** in the early stages consists in the application of evaporating lotions, and later on, if the blood-clot is not absorbed, the cavity may be laid open and the coagulum removed.

Rupture of the Vas Deferens has resulted from excessive strain; it is, however, very rare, not more than half a dozen cases being on record. It may affect the intra-abdominal portion of the vas, and then gives rise to hæmorrhage from the urethra, together with some amount of fever and hypogastric pain, leading possibly to atrophy of the organ. Rupture of the scrotal portion is followed by enlargement of the testis, and perhaps scrotal hæmorrhage. This was associated in a case recently under observation with hæmorrhage from the urethra on attempting coitus shortly after the accident, and subsequently to severe pain and swelling of the testis produced by the same act, but atrophy did not follow. If it occasions any inconvenience, it is best treated by castration.

Inflammatory Affections of the Testis.

Inflammation of the Testicle may be chiefly confined at its onset either to the body of the organ or to the epididymis; in the former case the term **Orchitis** is applied to it, in the latter **Epididymitis**; either condition may be acute or chronic.

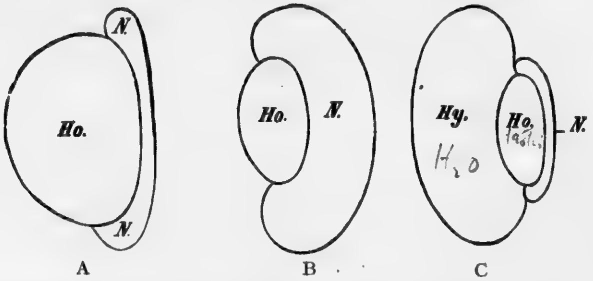


FIG. 362.—DIAGRAMMATIC SECTIONS OF ORCHITIS, EPIDIDYMITIS AND HYDROCELE OF TUNICA VAGINALIS. (TILLMANNS.)

Ho, Testis; *N*, epididymis; *Hy*, hydrocele.

Acute Orchitis most frequently results from injury, but it is also met with as a primary affection in gouty and rheumatic individuals, apparently arising spontaneously; or it may follow mumps or other eruptive fevers, as a result of metastasis, whilst it is often associated secondarily with epididymitis.

Phenomena.—The testicle becomes enlarged, exceedingly painful, and tender to the touch. The shape of the organ is more or less globular (Fig. 362, A), whilst the pain is of a peculiar character, tending to produce vomiting, and extending upwards along the course of the cord towards the back and loins. The scrotal integuments become red and infiltrated, and, owing to the acuteness of the process, more or less adherent to the coverings of the gland. A plastic or serous effusion into the tunica vaginalis is sometimes present, giving rise to what is known as an 'acute hydrocele.' Considerable constitutional disturbance accompanies the process, the temperature being elevated two or three degrees, whilst vomiting and constipation are marked symptoms. It is unusual for the process to go on to suppuration, but an abscess occasionally forms, and then after the pus has been evacuated a hernia testis may follow. Atrophy is a more common sequela, especially in adults, being caused by constriction of the vessels and tubules, owing to organization of the inflammatory exudation.

Acute Epididymitis is almost always due to the extension of an inflammatory process from the urethra, the usual cause being gonorrhœa; it occasionally follows the passage of instruments or the lodgment of a calculus; or it may be secondary to a suppurative prostatitis unconnected with gonorrhœa. It is ushered in by pain in the inguinal region, and perhaps in the hypogastrium along the course of the vas deferens, and this soon extends to the scrotum. The testicle becomes enlarged, but its shape is that of an elongated oval, somewhat flattened laterally. The epididymis can be readily felt as a crescentic swelling, partially overlapping the gland in all directions, and in its concavity the rounded outline of the anterior wall of the testis can usually be distinguished (Fig. 362, B), or the tunica vaginalis distended with fluid. The scrotum is also red and œdematous, whilst the cord is infiltrated, enlarged, and tender. The same constitutional symptoms are met with as in orchitis. Suppuration is perhaps more common in epididymitis than after orchitis, since the condition is usually due to an extension from a suppurating inflammation of the deeper parts of the urethra; but it is a rare complication. Atrophy of the testis is a not unfrequent result in cases which are not efficiently treated, the plastic material exuded into the epididymis being organized into fibro-cicatricial tissue, and constricting the spermatic vessels; an acute attack of double epididymitis may in this way render the individual sterile.

G. ←

Egg in
egg cup!

The **Treatment** of both these conditions in the acute stage consists in keeping the patient in bed, with the scrotum supported on a small pillow. Hot fomentations are assiduously applied, except when the case is seen very early, when an icebag or Leiter's coil may be employed. Leeching should not be utilized, as the triangular leech-bites are very liable to become irritated and septic, and never heal well in the scrotum; if local abstraction of blood appears desirable, one or more of the scrotal veins may be punctured; the hæmorrhage is easily arrested by elevating the part. Pain, if severe, may be mitigated by a hot sitz-bath, or by morphia suppositories. As regards general treatment, the patient, after a preliminary dose of calomel, is kept on a fluid, unstimulating diet; whilst alkaline purgatives are administered, with the addition of tincture of henbane or opium as a sedative; if the pulse is hard and the temperature high, vinum antimonialis in 10 minim doses is also beneficial. When the acute stage is passed, the organ usually remains enlarged, and for a time somewhat tender; it is then best treated by strapping with lead plaster, or with the emplastrum ammoniaci cum hydrargyro. This must be continued until all signs of thickening and induration have disappeared.

Subacute or chronic forms of inflammation are also met with affecting the testis or epididymis, either as a consequence of the above, or resulting primarily from blows or strains. The characteristic enlargement is readily detected, associated with a certain amount of tenderness. The condition is best treated by strapping, and perhaps the administration of small doses of mercury and iodide of potassium may assist in the absorption of the inflammatory products. Chronic orchitis is very similar to the enlargement produced by syphilis, from which, indeed, it can only be distinguished by the absence of a syphilitic history.

Tubercular Disease of the Testis (*Syn.:* **Tubercular Sarcocele, Chronic Tubercular Orchitis**).—This affection is most commonly seen in young adults with a distinct tubercular history, but it also occurs in otherwise healthy individuals. It may commence as a primary affection of the epididymis, or it may be secondary to tubercular disease elsewhere.

N.B. the begins usually in the globus major.

Pathological Anatomy.—The tubercular process originates in the connective tissue of the epididymis, and runs its usual course, at first consisting merely of miliary elements deposited around the vessels, which by their coalescence and caseation lead to the formation of cheesy masses, and these at a later stage may emulsify and give rise to abscesses. This process may be limited to any one part of the epididymis (most often the globus major), or may widely infiltrate its substance, causing a general enlargement (Fig. 363). In the latter case it early tends to spread, either into the body of the testis or along the vas deferens. The corpus Highmorianum becomes first involved by a similar deposit, and finally the intertubular connective tissue of the gland; this is always associated with overgrowth of the epithelium in the tubuli seminiferi, the cells after a time undergoing fatty degeneration, and perhaps to such an extent that, on microscopic section, the normal appearance of the organ has entirely disappeared. An abscess may form within it, and find its way to the surface by burrowing through the tunica albuginea, the visceral and parietal layers of the tunica vaginalis having previously become adherent. After the pus has been evacuated, a hernia testis is likely to develop. If the process extends upwards along the cord, the vas

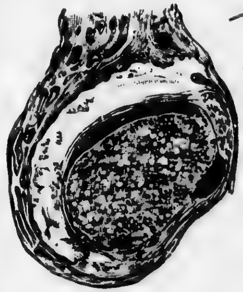


FIG. 363.—TUBERCULAR DISEASE OF TESTIS, MAINLY AFFECTING THE EPIDIDYMIS. (TREVES' 'SURGERY.')

is mainly implicated, becoming perceptibly thickened, the other structures of the cord being but little affected. The disease tends to spread along the side of the bladder to the vesiculæ seminales and prostate, and may even involve the base of the bladder, the ureters, and kidneys. Lastly, acute miliary tuberculosis, or tubercular phthisis, may result from general dissemination of the infected material.

Clinical Signs.—The disease is generally unilateral, although the other testicle may become involved at a somewhat later date. In the earliest stages, one or more firm and indurated nodules are felt in the epididymis, which are free from tenderness, but more often the whole of this structure is found to be enlarged and thickened, forming a painless crescentic swelling, surrounding the posterior half of the body of the testis, from which it is usually separated by a deep groove or sulcus. The epididymis is nodular and craggy to the feel, and may be of unequal consistency, areas of softening being interposed between portions which are distinctly hard. The vas early becomes thickened, and when the body of the testis is involved, it also becomes enlarged, the line of demarcation between it and the epididymis becoming indistinct. Testicular sensation remains as long as any normal glandular substance exists, but effusion into the tunica vaginalis is not a common complication. When suppuration occurs, the pain increases, especially if the abscess is in the substance of the organ. As it finds its way to the surface, the skin becomes adherent to the testis, and is red and congested. Gradually fluctuation manifests itself, and if the pus is evacuated a hernia testis is likely to follow. An abscess forming in connection with the epididymis is less painful, and may attain considerable dimensions before it bursts; it is never followed by a hernia testis. Extension of the disease to the seminal vesicles gives rise to no characteristic features, and is only detected on rectal examination; when, however, the base of the bladder and prostate are affected, considerable dysuria and irritability of the bladder are induced.

The differential diagnosis is discussed at p. 1089.

Treatment.—There can be no doubt that, when once tubercular disease has involved the testicle to such an extent as to render its diagnosis certain, the sooner the organ is removed, the better. This applies especially to the poor. Amongst the rich, if seen in the very earliest stage, when only a small nodule exists in the epididymis, it is possible that prolonged residence at the seaside, or a sea-trip, combined with suitable constitutional treatment, may lead to its disappearance. Moreover, if apparently strictly limited to one portion of the epididymis, it may be dealt with by the conservative measure of cutting down on the site of the disease, scraping it away, and applying pure carbolic acid; but such measures are seldom feasible, since the disease has usually progressed too far, whilst it must be remembered that the function of the organ is almost certain to be thereby seriously impaired, if not destroyed. For a description of castration, see p. 1090. In tubercular disease, it is always important to divide the cord as high up as possible. If the vas is thickened at the external abdominal ring, it need not deter the surgeon from operating, even if the vesiculæ are enlarged, since tubercular disease is not like cancer; if the great bulk of the mischief is removed, Nature can frequently eliminate any small portion that remains. In such cases the inguinal canal should be freely opened, and the vas traced backwards and divided. In one case thus dealt with, the bladder was distended with boracic lotion, the patient placed in the Trendelenburg position (p. 1036), and the vas followed back along the side of the bladder nearly as far as the seminal vesicles.

Syphilitic Disease of the Testicle.—The testicle may become affected by syphilis, either in the late secondary or in the tertiary stage; most commonly it results from the acquired variety, but occasionally it is met with in the inherited.

Secondary Syphilitic Epididymitis is not very frequently seen. It occurs in the form of a chronic enlargement of the epididymis, associated perhaps with a hydrocele, about six to twelve months after infection. The case is very similar to a simple chronic epididymitis, presenting a nodular thickening mainly of the globus major, and only differing from the simple form in the fact that it is due to syphilis, and needs anti-syphilitic treatment for its removal. Both testes are usually involved. It readily disappears on the administration of mercury.

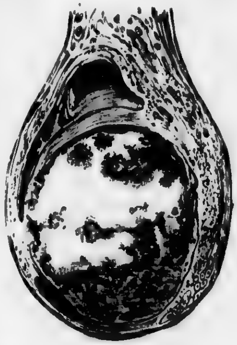


FIG. 364.—TERTIARY SYPHILITIC DISEASE OF TESTIS WITH GUMMA OF THE BODY. (TREVES' 'SURGERY.')

Tertiary Syphilitic Orchitis appears at a much later period of the disease, even twenty or thirty years after infection. It is not unfrequently bilateral. **Pathologically**, it resembles the majority of tertiary manifestations in consisting of a diffuse infiltration accompanied by overgrowth of the connective tissue. If the process affects equally the whole organ, the ordinary syphilitic sarcocele or sclerosis of the testis results; if it is more especially localized to any particular spot, the gummatous variety is said to be present (Fig. 364). The former affection is much more common than the latter.

In the tertiary syphilitic sarcocele, the body of the testis is primarily involved, and becomes evenly enlarged and stony hard.

Syph Sarcocele = Sclerosis of testis – a tertiary manifestn
Gummatous Orchs – less common –
Syph Epididymitis = late secondary – usually bilateral –

It is globular in outline, frequently accompanied by a hydrocele, and the normal testicular sensation early disappears. The same process occasionally extends to the epididymis and cord. Suppuration is exceedingly rare. On section the characteristic appearance of a testicle has entirely vanished; the tunica albuginea is much thickened, and extending from it through the substance of the mass are thickened bands of connective tissue, representing the normal septa; in bad cases the gland substance is almost completely destroyed.

In the *gummatous* variety a similar condition involves the greater part of the organ, but in one or more spots yellowish-white masses of newly formed connective tissue are also present. The central portions of these foci are non-vascular, but there are bloodvessels in the periphery, which is generally distinctly defined. The usual degenerative changes follow, the centre becoming soft and diffluent, and if the gumma comes to the surface the skin may give way, and a deep syphilitic ulcer with a sloughy base like wet wash-leather results. Hernia testis very rarely follows such an occurrence. The clinical features of the gummatous variety are at first similar to those of the former, but after a time one portion of the organ becomes prominent and painful, and as this increases in size the central parts become soft and fluctuating, and finally yield, giving exit to the characteristic gummy contents. Under suitable treatment the swelling in each of these varieties may disappear entirely, leaving the testicle either of normal size or atrophied; but, as in tubercular disease, its functional utility, if not entirely destroyed, is probably considerably impaired.

For the differential diagnosis see p. 1089.

Treatment consists in the administration of iodide of potassium and mercury, whilst the hydrocele may be tapped, and the organ strapped or supported by a suspender. If a gummatous ulcer is produced, it may be possible to excise the greater portion of the characteristic slough at its base; but in all cases it should be dressed with lint dipped in lotio nigra, or some other mercurial preparation.

Hernia Testis is the term applied to a protrusion of the substance of the gland, more or less infiltrated with granulation tissue, through an opening in the tunica albuginea and skin of the scrotum. It arises from various causes, such as a septic penetrating wound of the testis, acute suppurative orchitis, or from a chronic abscess, whether simple or tubercular in nature. It is rarely produced by the breaking down of a gumma, owing to the extensive infiltration of the organ with fibro-cicatricial tissue, and necessarily it never follows suppuration in the epididymis. It is therefore always preceded by a condition of increased pressure within the tunica albuginea, and consequently as soon as an aperture is formed in this membrane, its natural elasticity, allowing of its contraction, forces a portion of its contents out of the opening; this may even proceed to such an extent as to cause the whole of the substance of the gland to protrude, the tunica albuginea being practically turned inside out. A mass resembling granulation tissue is then seen to project through an opening in the scrotum; it is often somewhat pedunculated or mushroom-like in shape, possibly overhanging the margins of the skin, but in less advanced cases the integument may be distinctly undermined. A considerable discharge of pus usually accompanies it. The condition must be distinguished from the fungating growth which occasionally results from malignant disease of the organ; in the latter case the protrusion consists of tumour substance, in which there is no trace of testicular tissue.

The **Treatment** of hernia testis usually consists in extirpation of the organ, especially when it is affected by tubercular disease. In simple cases it may be possible to obtain healing of the wound by keeping the part aseptic, and applying pressure by means of a pad of gauze. In other cases it may be possible to separate the mass, and, after paring the edges of the wound, to bring them together by sutures, and thus cover in the gland substance, which, however, remains projecting from the opening in the tunica albuginea. Such proceedings are seldom very satisfactory.

Tumours of the Testis are generally malignant in character, only one non-malignant form being at all common, viz.: fibro-cystic disease, or adenoma testis.

Adenoma Testis (*Syn.:* **Cystic Sarcoma, Cystic Sarcocele, Fibro-Cystic Disease**).—This condition is characterized by the formation of a tumour of variable size, scattered through the substance of which are numerous cystic cavities, lined with cuboidal or stratified epithelium (Fig. 365). These cysts are usually rounded, but occasionally tubular in shape, and may communicate with one another; they contain serous fluid, and sometimes intracystic growths. They are surrounded by connective tissue, the amount of which varies greatly in different cases. It consists usually of simple fibrous tissue, but very commonly has cartilaginous nodules scattered through it, and may even undergo myxomatous or sarcomatous changes. According to Bland Sutton and Eve, these tumours arise from the remains of the Wolffian body or meso-nephros, which is almost always normally represented in the neighbourhood of the globus major of the epididymis by the structure known as the organ of Giraldés (paradidymis). The testicle can be found in most cases spread out in a thin layer over the tumour substance.

Clinical Signs.—This condition is met with in young adults, and may possibly be attributed to an injury. The organ steadily becomes enlarged, but this gives rise to no inconvenience except by its size and weight. It is round in outline and elastic in consistency, the cord remaining unaffected unless sarcoma supervenes. When of great size, the skin of the scrotum may ulcerate. As a rule, the case runs a very chronic course, and even should the growth become malignant, the change of type only appears late in the disease.

Treatment consists in removal after an exploratory incision has demonstrated the nature of the growth.

Other non-malignant tumours have been described, such as chondroma, osteoma, fibroma, myxoma, etc., but they are exceedingly uncommon, if they occur at all apart from sarcoma or fibro-cystic disease.

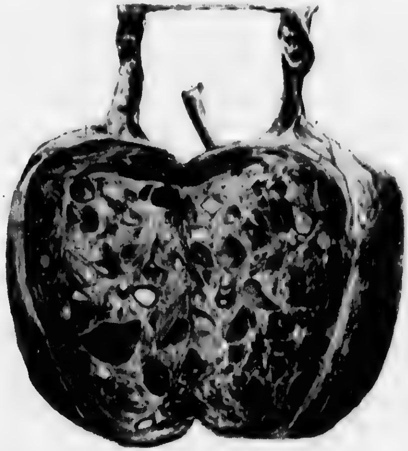


FIG. 365.—ADENOMA TESTIS. (COLLEGE OF SURGEONS' MUSEUM.)

Sarcoma of the Testis commences in the body of the organ, either within the first decade of life or between the ages of thirty and forty, and is a not uncommon sequela of late or imperfect descent. It is usually a soft, round-celled growth, sometimes taking on the form of a lympho-sarcoma; in other cases it is harder, and of the nature of a fibro-sarcoma. Frequently cartilaginous nodules are incorporated in its substance, and patches of myxomatous tissue or cystic degeneration from hæmorrhage are also seen. As already stated, it is sometimes secondary to fibro-cystic disease. It originates in the connective-tissue elements of the organ, the glandular substance being early destroyed. It appears as a rounded swelling, and at first its outline is irregularly smooth. As the disease progresses, however, it may become nodulated from the development of cysts, or from the existence of isolated masses of cartilage. The tumour may attain very large dimensions, but the cord and scrotal tissues only become affected in the later stages, and then ulceration and the formation of a fungus testis may occasionally follow. Secondary growths are always found in the lumbar glands and internal organs, whilst, when it has spread beyond the tunica albuginea, involving the scrotal structures, the inguinal glands may be similarly affected. There are but few subjective symptoms at first, a feeling of weight and dragging being alone experienced, whilst testicular sensation is soon lost; but at a later date, when the cord is involved, pain and cachexia become very marked. The **Course** of these cases is slow up to a certain point, but the tumour may then rapidly increase in size, spreading along the cord to the interior of the abdomen even in the course of a few weeks, thereby rendering removal utterly impossible, although it would have been easily practicable at an earlier period. **Treatment** consists in the extirpation of the growth with the testis at as early a date as possible, the cord being divided high up.

like Syph

Carcinoma of the Testis is usually of the encephaloid type, and arises in the body of the organ as a soft rapidly growing tumour, which soon extends to the tissues of the cord, and contracts adhesions to the scrotum; ulceration and the formation of a fungating mass follow, whilst secondary deposits are found in the lumbar and inguinal glands, and sometimes in the viscera. It is impossible to distinguish a carcinoma from a soft sarcoma of the testis by clinical signs, since it occurs at the same period of adult life, although never in children. Very rapid growth, and early enlargement of the cord and lymphatic glands, point, however, to cancer rather than sarcoma. The only treatment is castration.

Hydrocele.

Good Friday 21/4/05

Any collection of fluid, other than pus or blood, in the neighbourhood of the testis or cord, is termed a **Hydrocele**. The fluid usually consists of serum, but in some forms spermatozoa are also present, and in rare cases it may consist of chyle or a similar milky fluid (chylous hydrocele). Two chief varieties are described, according to whether the testis or the cord is involved.

I. In **Hydrocele of the Testis** the fluid is contained in the tunica vaginalis (vaginal hydrocele) or exists as a circumscribed swelling in its neighbourhood (encysted hydrocele).

1. A **Vaginal Hydrocele** is one in which there is an accumulation of fluid in the tunica vaginalis, and the following varieties may be differentiated:

(a) *Acute Hydrocele* occurs in conjunction with acute inflammation of the testis or epididymis. The effusion of fluid is never abundant, and is often only made out on careful examination; at first it consists of plasma, as in all acute inflammations of a serous membrane, and is therefore spontaneously coagulable. It may merge into the chronic type, or may disappear entirely, perhaps leaving a few adhesions.

(*b*) A *Congenital Hydrocele* occurs in cases in which the funicular process is still patent. The general signs of a vaginal hydrocele, as described below, are present, but the fluid can be returned by pressure into the abdominal cavity. It is rarely seen in others than infants, and may be treated by the application of evaporating lotion to the scrotum, whilst a light truss or woollen support is placed over the inguinal canal, as for congenital hernia. It is often associated with phimosis, which should of course be dealt with by circumcision. If it persists, it may be treated by operation as for congenital hernia, to which, indeed, it frequently leads.

(*c*) An *Infantile Hydrocele* is one due to non-obliteration of the funicular process of peritoneum, except at its upper extremity. It presents the signs of an ordinary acquired hydrocele, the fluid, however, extending along the cord, even into the inguinal canal. Its treatment is the same as for the acquired variety.

(*d*) *Acquired Vaginal Hydrocele* is the most common. **Causes.**—It may arise idiopathically in middle-aged persons, and has then been looked on as resulting from some functional disorder rather than from any organic change in the membrane, the normal balance between secretion and absorption being disturbed. In the majority of cases, however, the testicle is swollen and perhaps in a state of chronic inflammation, and the tunica vaginalis thickened. A hydrocele almost always accompanies a tertiary syphilitic enlargement of the organ, but it is uncommon in tubercular or malignant disease. Hydrocele is very frequently seen in those who dwell in hot climates, probably as a result of the lax and pendulous conditions of the scrotum and testicles. In India natives always support the scrotum by passing the end of their 'kummerbund' between their legs, in order to prevent such a development.

Signs.—Vaginal hydrocele appears as a rounded pyriform swelling in the scrotum, which extends for a variable distance along the cord. Its tension differs with the amount of fluid present, and with the thickness of its walls; it is generally elastic, and fluctuation obvious. The cord is felt distinctly above the rounded upper part of the tumour, and the testis is generally situated posteriorly (Fig. 362, C), although it projects forwards into the cavity, and is thus not readily felt. Its position may be ascertained by pressure over it, when the characteristic testicular sensation is evolved. On holding a light close to the scrotum, the tumour is seen to be translucent, and the position of the testicle can be demonstrated. In old-standing cases the walls become exceedingly thick, and even cartilaginous or osseous plates have been observed in them; the translucency in such cases will be lost. Occasionally, when inflammation has existed, adhesions may form between the testis and the anterior wall, and irregularity in the shape of the tumour is thereby induced, or the cavity may be divided into compartments by fibrous bands or septa.

It is scarcely necessary to mention that there is no impulse on coughing, and that the tumour is dull on percussion. When the distension is very great, its weight causes a dragging pain; the penis becomes buried in the swelling, and eczema of the scrotum may result from the urine trickling over it. The *fluid* in the sac is yellowish or straw-coloured; its specific gravity varies from 1015 to 1025; it contains a large amount of albumin, especially fibrinogen. In old-standing cases cholesterin may also be present.

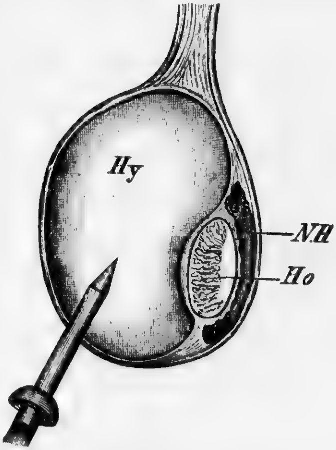


FIG. 366.—METHOD OF TAPPING A HYDROCELE. (TILLMANNS.)

Ho, Testis; *NH*, epididymis; *Hy*, hydrocele.

The **Treatment** of vaginal hydrocele is palliative or radical. **Palliative** treatment consists in tapping the cavity and removing the fluid, the patient being subsequently directed to wear a suspender, and, where inflammation of the testis exists, to apply cooling lotions. In infants it can often be cured without tapping by simply applying an evaporating lotion. In order *to tap a hydrocele*, the tumour must be firmly grasped in the palm of the hand, and the skin over its anterior wall made tense and purified. A spot at the antero-inferior margin is then selected, as free from vessels as possible, and a fine sterilized trocar and cannula inserted in a direction almost directly upwards, so as to pass in front of the body of the testis. The site selected for tapping must of course vary with the position of the testicle, which should be previously made out. The fluid having been withdrawn, the cannula is removed, and the puncture covered with some wool and collodion. The condition recurs after a longer or shorter period, and the operation must be repeated. If a dirty instrument is employed, inflammation, and even suppuration, may follow, whilst if a vessel or the body of the testis is punctured, a hæmatocele may result.

Many different plans have been suggested for the **Radical** treatment of hydrocele. It is unnecessary, however, to do more than describe the two most frequently adopted. (i.) *Injection* of the cavity after tapping has long been a favourite method of treatment. Many different reagents have been employed, such as port wine, tincture of iodine, solution of corrosive sublimate (1 in 500), or glycerine of carbolic acid. Perhaps the best is the tincture of iodine, but that contained in the British Pharmacopœia is not strong enough, and the old Edinburgh tincture, which is nearly the same strength as the lin. iodi, B.P., should be employed. The amount used varies with the size of the hydrocele, but for one of moderate dimensions it will suffice to inject, after tapping, 2 drachms of the tincture, and after manipulating it well within the cavity, a part, say 1 drachm, is allowed to escape. Smart inflammatory reaction follows, and a cure will probably result, either from obliteration of the vaginal space by the formation of adhesions, or by impressing some change of function upon the serous membrane. In a certain percentage of cases failure may be expected, and this is especially likely to happen if too weak an irritant has been employed, or if the hydrocele is a chronic one with thick and indurated walls, and has been tapped on several previous occasions. (ii.) The *open method* of operation is now frequently adopted, and is particularly recommended in large and chronic cases. The hydrocele is cut down on through an incision in the upper part of the scrotum, and the tunica vaginalis isolated from the superjacent structures. The cavity is then opened, and the parietal portion of the tunica snipped away with scissors close to the testicle. A number of vessels will need to be ligatured; a drainage-tube is inserted, and the wound closed in the ordinary way. The results of this practice have been most satisfactory.

2. **Encysted Hydrocele** of the testis occurs in two main forms, according to whether it arises in connection with the epididymis or the body of the testis.

(*a*) *Encysted Hydrocele of the Epididymis* exists usually as a rounded globular swelling, tense and elastic in consistency, and translucent. It is situated above the body of the testis, and close to the head of the epididymis. As a rule, it does not attain a size greater than that of the body of the testis itself, so that it may appear as if a double testicle was present; the hydrocele is, of course, devoid of testicular sensation. Less frequently it may attain considerable dimensions, even projecting below and around the testicle, which, though enveloped by it, is quite distinct from it. The fluid contained within these cysts is usually milky and opalescent in appearance, owing to an admixture of semen; under the microscope spermatozoa, either living or dead, can be demonstrated; on account of this it is sometimes termed a *spermatocele*. The specific gravity is lower than that of ordinary hydrocele fluid, and there is less albumin.

The origin of these cysts has given rise to much discussion. They are of a very different nature to the ordinary vaginal hydrocele, or even to the encysted hydrocele of the cord, since the walls are not lined with endothelium, but with cuboidal or columnar epithelium. They are probably due either to a dilatation of the vasa efferentia testis, or more frequently to distension of some of the fœtal relics always found near the head of the epididymis, especially of those known as Kobelt's tubes; these, as also the vasa efferentia testis, are derived from the tubules of the Wolffian body, differing, however, from them in not becoming attached to the body of the testis (Fig. 46). They are thus homologous with the parovarian cysts found in the female. Smaller pedunculated cysts containing clear serum are sometimes met with in this region, arising from a distension of the hydatid of Morgagni, which is developed from the remains of the Müllerian duct.

Treatment is conducted along the same lines as for vaginal hydrocele, viz., by tapping as a palliative measure, and injection or excision, in order to establish a radical cure.

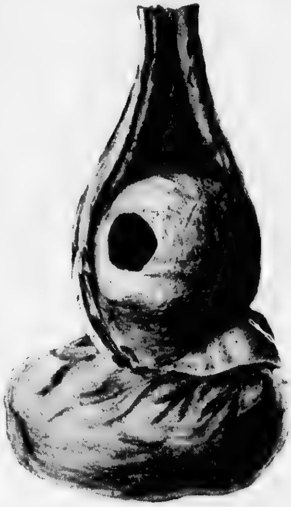


FIG. 367.—ENCYSTED HYDROCELE OF EPIDIDYMIS. (COLLEGE OF SURGEONS' MUSEUM.)

(*b*) *Encysted Hydrocele of the Tunica Albuginea* is a condition rarely seen, consisting of a small collection of serous fluid beneath the visceral portion of the tunica vaginalis. It is probably due to dilatation of lymphatic spaces, and is absolutely of no significance.

II. **Hydrocele of the Cord** may occur, as already described, in connection with a vaginal hydrocele in the congenital and infantile varieties. If limited to the cord, it exists in one of two forms, the encysted or the diffuse.

1. **Encysted Hydrocele of the Cord** arises from imperfect obliteration of the funicular process of peritoneum, the patent portion becoming distended with fluid and giving rise to a cavity lined with endothelium. It usually occurs as a rounded elastic swelling, occupying the inguinal canal, moving freely up and down within it. The upper border is sharply limited, and in favourable cases translucency can be detected. On fixing the testicle the

cyst is no longer moveable. The fluid contained within it is identical in nature with that in a vaginal hydrocele. **Treatment** consists in removal of the fluid by tapping, or, if a more radical proceeding is necessary, injection or excision.

2. **Diffuse Hydrocele of the Cord** is but rarely seen. It results from a diffuse œdema of its cellular tissue, and presents on examination a fusiform or sausage-shaped tumour, which extends along the cord for a variable distance.

The term **Chylous Hydrocele** is applied to a distension of the tunica vaginalis with a chylous fluid, recognised by being milky in appearance, and under the microscope is seen to consist of a fatty emulsion. Several modes of origin have been suggested, but none are very satisfactory. In a case recently under treatment, a series of dilated lymphatics filled with a similar fluid extended upwards from the testicle to the inguinal canal.

Varicocele.

A varicose condition of the pampiniform plexus is very commonly met with in young men, but seldom in those of advanced age, except when it has become chronic, or is due to malignant disease of the kidney (p. 997). It usually occurs in individuals with a lax and pendulous scrotum, and is often associated with masturbation, which induces abnormal vascularity of the testis. It may also be caused by the pressure of a truss applied for the relief of a hernia. It is almost invariably seen on the left side and the reasons given for this are as follows: (*a*) The left testis usually hangs lower than the right, and hence the spermatic veins are longer and exposed to greater blood pressure. (*b*) The left spermatic vein opens into the left renal vein at right angles, and no valve is present at the orifice, whilst that on the right side opens obliquely into the vena cava and is valved. (*c*) The presence of the sigmoid flexure on the left side of the body, and its distension by accumulated fæces as a result of constipation, may lead to pressure on the abdominal portion of the left spermatic vein.

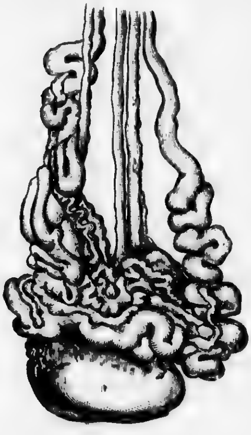


FIG. 368.—VARICOCELE. (TREVES' 'SURGERY.')

A varicocele is characterized by the presence of a soft irregular swelling in the scrotum, which is somewhat pyramidal in shape, the main mass being below and slightly overlapping the testis, and the apex above. It consists of dilated and tortuous veins, the outlines of which can often be seen through the skin; they impart a sensation to the finger which has been likened to a collection of worms in a bag; there is a distinct impulse down the veins on coughing. On assuming the recumbent posture the swelling almost disappears, owing to the vessels becoming emptied of their contained blood; if pressure is subsequently applied over the external abdominal ring, and the patient allowed to stand, the tumour reappears, filling from below upwards. A sensation of weight and pain usually accompanies a varicocele, whilst severe neuralgia of the testis may be induced. It is a frequent source of seminal emissions, and may result in testicular atrophy. Phlebitis is liable to follow an injury, and may lead to a spontaneous cure; if one of the dilated veins is ruptured, severe hæmorrhage ensues, causing a diffuse hæmatocele of the cord. In favourable cases the condition may after a while spontaneously disappear.

The **Diagnosis** of varicocele is easily made, the only condition for which it is likely to be mistaken being an omental hernia; the difference between the two conditions has been discussed at p. 916.

The **Treatment** of slight cases of varicocele consists of supporting the testicle and scrotum by means of a well-fitting suspender, whilst the patient is also instructed to bathe the parts with cold water every night and morning, and to take such measures as shall ensure a daily action of the bowels.

Radical Treatment by excision of the veins is advisable in neuralgic cases, where atrophy of the testis is threatening, or in order to fit the patient for admission into any of the public services. The operation is conducted as follows: The pubic region having been shaved and purified, an incision 2 inches long is made in the direction of the cord, with its centre a little below the external abdominal ring. The structures of the cord are raised on the fingers, and the coverings divided, so as to expose the spermatic veins at their upper end. Two main branches are usually found in this situation, but occasionally there is only one. These are cleaned and carefully isolated from the other structures of the cord, and a ligature is applied to them at the external abdominal ring. The vessels are now clamped with a pair of Spencer Wells' forceps below the ligature, and divided between it and the forceps. The lower end, grasped by the forceps, is now stripped downwards, so as to free the pampiniform plexus from the other elements of the cord, and the dissection can be carried nearly as far as the epididymis by drawing the testicle up into the wound. The lower end of the veins is now ligatured in one or two portions, and divided. By this means the whole varicocele is removed. If the scrotum is pendulous, and the testicle hangs low, it may be advisable to raise it by tying the upper and lower ligatures together, care being taken not to pull them off in so doing. The wound is then closed without a drainage-tube, and dressed as usual. The patient is kept in the recumbent posture for ten days or a fortnight, until a firm cicatrix has formed. This method of treatment is infinitely superior to that usually practised of exposing the veins in the scrotum, since a wound in the groin always heals much more readily than one in the scrotum; whilst it is easier to dissect the veins out from above, where only one or two trunks exist. The venous return after the operation is maintained by a vein which is always present in the posterior portion of the cord.

Neuralgia of the Testis is characterized by the organ becoming exquisitely tender and painful, although apparently healthy. It usually occurs in young adults of nervous temperament, or in middle-aged gouty men. It is not uncommonly associated with a varicocele. The pain is usually paroxysmal in character, and very intractable.

Treatment must be directed mainly to the general health, consisting in the administration of nerve tonics, such as iron and quinine, whilst locally sedatives, such as belladonna and aconite, may be applied. It is also advisable for a suspender to be worn.

Atrophy of the Testis results from several causes: (i.) It may be due to a congenital arrest of development, as met with in displacement or late descent. (ii.) It is most frequently the consequence of inflammatory affections, either of the body or epididymis, owing to the cicatricial contraction caused thereby leading to compression of the vessels. It occasionally follows the metastatic orchitis of mumps, especially in adults; whilst it is also due to syphilitic disease. (iii.) It may arise from impaired nutrition, such as the division of the spermatic arteries in the operation for varicocele or hernia, or from compression of the cord by closing the inguinal canal too firmly in the operation for the radical cure of hernia. (iv.) Chronic congestion of the organ, as by a varicocele, may induce atrophy; whilst (v.) sexual excesses are also stated to lead to it. If unilateral, it is of comparatively little importance; but where both organs are affected, sterility is sure to result, and the patient, if previously young and healthy, is likely to become depressed in spirits and melancholic. This may be due in part to mental causes, but also in measure to the absence of seminal secretion, the reabsorption of which into the system is, according to Brown-Séquard, an important factor in the maintenance of a vigorous state of mind and body.

General Diagnosis of Scrotal Tumours.

The diagnosis of the different forms of enlargement of the testis described in this chapter has been purposely omitted to prevent needless repetition. Moreover, there are other scrotal conditions with which they may be confused, and it is better to discuss the whole subject at one time.

When a patient presents himself for examination with a swelling in the scrotum, the surgeon has to decide whether it is a hernia, a hydrocele, a hæmatocele, a varicocele, or a solid enlargement of the testis, and, if the latter, of what nature. The first point to which attention is directed is the condition of the cord immediately below the external ring. If this is of normal size and consistency, hernia and diffuse hydrocele of the cord are thereby excluded, whilst the existence of a rounded tense swelling, moveable within the canal, but becoming fixed on holding the testis, indicates that an encysted hydrocele of the cord is probably present. When, however, the cord is more or less masked, further examination speedily determines whether a hernia or a diffuse hydrocele or hæmatocele of the cord exists, since the former is often reducible, has an impulse on coughing, and is rounded or nodular in outline, whilst the latter are sausage-shaped, always irreducible, and semi-fluctuating.

When the swelling is purely scrotal, inspection and manipulation will at once decide if it is a varicocele, by its characteristic feel, by its disappearance on assuming the recumbent posture, and filling again from below on standing up. If the swelling is rounded in outline, the next point to be determined is whether it is solid or fluid. If fluid, it is probably a hydrocele, or the early stage of a hæmatocele; the translucency of the former, and the sudden appearance and non-translucency of the latter, should suffice to demonstrate its nature. It is possible that the hydrocele is merely a secondary complication, and hence no final opinion should be given until it has been tapped, and the condition of the body of the testis investigated. If, however, a solid mass exists in the scrotum, it is either a hæmatocele in its later stages, or some form of sarcocele, whether simple, syphilitic, tubercular, or neoplastic. A *hæmatocele* is possibly recognised by its history, and by there being a fluid centre to the swelling, surrounded by solidified tissue. A *chronic orchitis* and a *syphilitic* enlargement of the testis are so much alike as to render diagnosis always uncertain in the absence of a distinct syphilitic history; but if the swelling is extremely hard, with a smooth and regular outline, without testicular sensation, limited to the body of the testis, and accompanied by a hydrocele, it is probably syphilitic. *Tubercular* disease, on the other hand, occurs more frequently in younger individuals than does the syphilitic variety, whilst the epididymis is usually first attacked, becoming nodulated, the cord is early implicated, hydrocele is rare, suppuration is frequent, and testicular sensation remains till the body of the testis is disorganized. *Tumours* always impart a distinct sense of weight to the hand, quite different to that noticed in tubercular or syphilitic disease;

if a simple tumour is present, it is rounded, slow in growth, and the cord is unaffected. Malignant disease is characterized by rapid growth, more severe pain, and early implication of the structures of the cord, and of the lumbar lymphatic glands. The enlargement of both testes is in favour of tubercle or syphilis rather than of malignant disease. A certain small number of cases will remain where, in spite of every care, the nature of the mass is still a matter of doubt; in such the diagnosis cannot be established without puncture or an exploratory incision.

Whilst weighing carefully the local conditions, we must not omit to thoroughly investigate and appreciate the general history and condition of the patient, his age, appearance, previous habits and illnesses, etc. At the same time, an examination of the internal organs should be made to ascertain, as far as possible, the presence of concurrent disease, *e.g.*, tubercular disease of the lungs or kidneys, or secondary malignant deposits.

Castration is required for many different conditions, which have been already described, *e.g.*, for malposition, tubercular disease, old-standing hæmatoceles, and simple or malignant tumours; it has also been undertaken for chronic enlargement of the prostate. The operation is conducted as follows: The pubes and perineum having been previously shaved and purified, the surgeon, standing on the same side of the patient as the organ to be removed, makes an incision down to the testis. If large and adherent to the scrotal tissues, the incision must necessarily be made in the scrotum, but wherever practicable it is wise to avoid the scrotal integuments, making the incision over the cord. It should always extend upwards as far as the external abdominal ring, so as to enable the structures of the cord to be divided high up, a most important matter in tubercular and malignant disease; the inguinal canal can then also be closed, as in the radical cure of hernia. The testis or tumour is enucleated from its surroundings, and the cord isolated, and divided as high as possible after transfixing and securely ligaturing it with silk. Some surgeons prefer to separate the tissues of the cord, and to take them up individually, but this is a matter of little importance. The stump should not be allowed to slip back into the canal until all bleeding has completely stopped, and the cut end may be touched with pure carbolic as a precautionary measure. Considerable attention was formerly directed to the condition of the pulse at the moment when the cord was divided, and it was a regular instruction to the anæsthetist, that if ether was being administered it should be pushed, whilst the amount of chloroform should be diminished. Such a distinction, however, is unnecessary, since it is now fully recognised that one of the best means of preventing shock is the maintenance of complete anæsthesia, the medullary centres being thereby guarded from the action of afferent stimuli;

consequently, it is only necessary that the patient should be fully under the influence of the anæsthetic. All bleeding points in the scrotum are now secured by ligature, and these may be numerous; the wound is closed by sutures, a drainage-tube being inserted in the scrotum, and coming to the surface at the upper end of the wound, that is, as far from the perineum as possible.

In the performance of double castration, it is recommended to make two crescentic flaps from side to side, so as to include between them a portion of the scrotal integument, in order to reduce the subsequent redundancy of unnecessary tissue.

Affections of the Vesiculæ Seminales.

Acute Vesiculitis is not often met with, but sometimes arises as a complication of gonorrhœa in association with prostatitis. It is characterized by deep-seated pain in the perineum, together with irritability of the neck of the bladder and increasing frequency of micturition. Defæcation becomes painful, and on examination of the rectum the vesiculæ can be felt enlarged and tender. If suppuration ensues, an abscess forms, which usually bursts into the rectum, but sometimes into the bladder or peritoneal cavity. As a rule, the condition disappears *pari passu* with the gonorrhœa; but when suppuration has supervened, it is advisable to open the abscess by a deep incision through the perineum, guided by a finger in the rectum.

Subacute or **Chronic Vesiculitis** is not uncommon, the latter condition being often associated with prostatitis, and one of the most frequent causes of gleet. Seminal emissions and priapism may be caused by it, and the enlarged organ can be felt on digital examination of the rectum. A good deal of pain, often referred to the back, is experienced. The treatment is the same as for chronic prostatitis.

Tubercular Disease attacks the vesiculæ seminales as a result of extension from the testis along the vas, being almost always associated with similar disease of the prostate and base of the bladder. The organs can be felt enlarged, and if suppuration occurs the abscess may burst into the rectum or bladder, or possibly into both, a recto-vesical fistula being thereby developed. It is possible to reach the vesiculæ through a semilunar incision in the perineum, displacing the rectum backwards, and the bladder and prostate forwards, or from behind by removing the coccyx and part of the sacrum, as in Kraske's operation. When exposed, an opening is made into them, and the cheesy contents scooped out.

Affections of the Scrotum.

Injuries of the Scrotum.—Contusions and blows give rise to ecchymosis, which may be so extensive as to warrant the term *hæmatoma scroti* which has been applied to it.

Incised wounds may affect the skin and subcutaneous tissues, or may lay open the tunica vaginalis with or without protrusion of the testicle. All that is needed in such cases is to render the wound aseptic, and to deal with it on general principles. Considerable destruction of scrotal tissue may be repaired by transplantation of flaps from the inguinal region, or by grafting according to Thiersch's method.

Cellulitis of the Scrotum most commonly results from extravasation of urine, for which see p. 1061. It may occasionally arise from other causes, but needs no special description.

Œdema of the Scrotum is usually due to dropsy, being often associated with general anasarca and ascites. It may attain considerable dimensions. *Acute inflammatory œdema* of the scrotum is a term sometimes applied to erysipelas affecting this region, on account of the absence of the vivid red colour usually associated with that affection. Considerable œdema is always present, and gangrene of the skin may result. As soon as the gangrene becomes limited, it should be excised, and the margins of the wound brought together by sutures, or allowed to heal by granulation.

Scrotal Fistulæ are usually due to the bursting of abscesses in connection with the urethra (see Perineal Abscess).

Sinuses of the Scrotum are often found in connection with tubercular or syphilitic disease of the testicle.

Eczema of the Scrotum is a troublesome affection, giving rise to great pruritus and irritation. It may result from the presence of pediculi, but the more chronic forms occur amongst workers in tar or paraffin, and also in chimney-sweeps, being due to the constant irritation of the corrugated scrotal integument by dirty clothes. Not unfrequently this condition runs on to epithelioma, originating the condition known as *chimney-sweep's* or *paraffin cancer* (Fig. 369). The usual characteristics of such a new growth are present, and in some of the deeper cells particles of soot have been demonstrated. The inguinal glands are usually involved at an early date. The only treatment which can be adopted is complete removal, the wound caused thereby being closed or allowed to granulate.

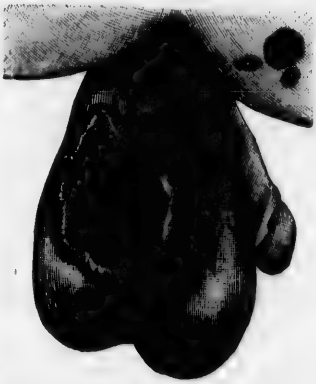


FIG. 369.—EPITHELIOMA SCROTI FOLLOWING PARAFFIN ECZEMA. (TILLMANNS.)

For **Elephantiasis Scroti**, see p. 308.

CHAPTER XXXVIII.

VENEREAL DISEASES.

THREE forms of venereal disease must be specially described, viz., gonorrhœa, soft chancre, and syphilis.

Gonorrhœa.

Gonorrhœa is an infective process due to the action of a specific micro-organism, the gonococcus (Fig. 370), and characterized by a discharge of pus from the urethra. The organism was first isolated by Neisser in 1879, and is found with or without other pyogenic cocci in the discharge, most commonly in the epithelial cells or pus corpuscles, but sometimes apart from them. They are readily demonstrated by staining a film of pus, dried on a cover-slip, with methylene blue or gentian violet, and are almost always found in the diplococcus condition, *i.e.*, they occur in pairs, held together possibly by some slight capsule; but often a considerable number, even up to twenty, are massed in a clump. The gonococcus is not easily cultivated, and it is also stated that inoculation experiments in animals have usually failed. The organisms find their way into the male urethra, and appear to invade the epithelial cells of the mucous membrane, within which they may often be seen; they determine an acute catarrhal inflammation, which quickly runs on to suppuration. One great characteristic of gonorrhœa consists in the readiness with which it extends from one part to another, and the ease with which even a healthy mucous membrane becomes affected by it, simple contact sufficing to determine an attack. Hence, although the symptoms

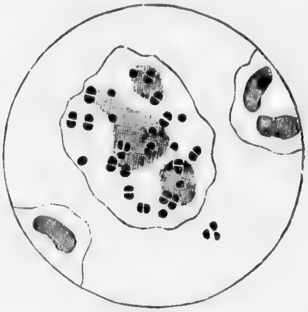


FIG. 370.—GONOCOCCI FROM URETHRA IN CELLS AND DISCHARGE.

are often very slight and insignificant, severe complications may arise, which may permanently cripple the individual, or even destroy life, especially if other pyogenic organisms are also present.

The Symptoms of Acute Gonorrhœa usually commence within a few days of the infection, varying from two to eight. Most commonly the discharge appears about the third or fourth day, being preceded by itching, quickly followed by scalding pain on passing urine. The lips of the meatus are thickened and swollen, and the discharge, which is at first thin and mucoid, soon becomes thick, abundant, and yellow in colour. This stage lasts for a variable time, and is sometimes associated with a good deal of constitutional disturbance and fever. The bowels are usually constipated, and the appetite impaired. Occasionally the swelling and congestion of the mucous membrane are so great as to lead to retention of urine, or hæmorrhage from the urethra. The first attack is always more serious than subsequent ones, although it is more amenable to proper treatment. Gouty and rheumatic people are especially difficult to treat, and often suffer from relapses after the discharge has apparently ceased, and it is said that fair people suffer more than those who are dark.

If suitable treatment is adopted, the discharge entirely ceases at the end of two or three weeks; but if neglected, or sometimes in spite of treatment, the case may become one of **Chronic Gonorrhœa** or **Gleet.** A more or less abundant discharge continues for some time without any other troublesome symptom than occasional scalding on passing urine. The discharge varies in consistency, but is often thin and muco-purulent, whilst sometimes, if due to chronic prostatitis, it may be so clear and transparent that it resembles uncooked white of egg. The causes of gleet vary in different cases; it is sometimes due to an ulcerated or granular condition of the mucous membrane, the discharge then being yellow, whilst in others it arises from chronic prostatitis, a condition not uncommonly associated with chronic enlargement of the vesiculæ seminales. The latter condition may be recognised on rectal examination, whilst, when the prostate is involved, flocculi of mucus in the shape of worm-like threads may be detected in the urine. A patch of granular urethritis should be suspected when one portion of the urethra is especially tender on the passage of a sound, but its presence can only be certainly recognised by the use of the endoscope.

Every purulent discharge is not necessarily gonorrhœal, since a simple urethritis may follow connection with a woman who is simply suffering from leucorrhœa, or has scarcely recovered from her menstrual period, but with no suspicion of a venereal taint. In these cases infection may be due to ordinary pyogenic cocci, or possibly to the *Bac. coli communis*, which is known to be not an unfrequent cause of vulvo-vaginitis. A diagnosis of simple urethritis may be suggested by the history, but only a microscopic examination of the pus, and a demonstration of the absence of gonococci, can establish it with certainty. At the same time, it must be remembered that gonococci are capable of remaining in a latent or passive state for a very long time in the folds or crypts of a mucous membrane, and hence there is a considerable likelihood of a person who has once suffered from it being capable of transmitting the disease, although there may be no evidence of its presence at the time.

In the **Treatment** of the early stages of acute gonorrhœa it is essential to maintain a free action of the bowels by alkaline purgatives, associated with a sedative, such as tincture of henbane. The diet should be light and unstimulating, and all alcoholic drinks prohibited, as also strong tea and coffee, whilst the patient should be recommended to take plenty of bland fluids, such as barley water or soda and milk. The scrotum should be supported in a suspender, and the patient advised against taking severe or prolonged exercise. No local treatment is necessary, although the use of hot hip-baths may relieve the pain and irritation; indeed at this period injections are harmful. The same treatment must be adopted as long as the discharge is copious, and the scalding continues. As soon as these symptoms moderate, oleo-balsams in the shape of oil of sandal-wood (10 minims, in capsules, three to six times a day), copaiva (10 minims, in capsules or mixture, thrice daily), or cubebs (½ to 1 drachm doses, wrapped in wafer-paper), may be advantageously employed. Both cubebs and copaiva, especially the latter, are capable of producing a bright-red erythematous rash which causes much irritation, and may be extensively diffused over the body.

The value of *injections* in the treatment of the disease has been much discussed, and is a point on which much difference of opinion exists. On the whole, we are inclined to think that many of the less severe cases of acute gonorrhœa can be successfully treated without them; but where the discharge tends to persist, or the urethra has been thickened by previous attacks, and especially in gleet, their use is imperative, but should never be employed when any local irritation or scalding is present. To use them with advantage, the following plan should be adopted: The urethra is first washed out, so as to remove any discharge from it; for this purpose the normal act of micturition answers admirably, so that the injection should be used immediately after passing water. The rounded nozzle of a small glass syringe, containing about half an ounce, is inserted into the meatus, the lips of which are compressed over it. The fluid is thrown into the urethra, and held there for about twenty seconds by compressing the orifice with the finger and thumb as the syringe is withdrawn; then, on relaxing the pressure, the fluid escapes. Other forms of syringe, on the principle of the indiarubber bottle, etc., are recommended, but perhaps the glass is the cleanest. Of the many different injections employed, perhaps the best consists of a mixture of tincture of catechu (10 minims to 1 ounce of water) and sulphate of zinc (2 grains to 1 ounce), or of permanganate of zinc (¼ grain to 1 ounce), or nitrate of silver (¼ grain to 1 ounce). The great secret consists in using the injection four or five times a day at first, and afterwards night and morning, even after all visible signs of the discharge have ceased. The fluid should always be warmed prior to use, and care taken not to use too strong a solution.

The **Treatment of Gleet** is always a matter of difficulty. The general habits of the patient must be attended to, as in the acute stage, whilst the bowels must be opened, and absolute sexual continence enjoined to prevent the spread of the infection. Large doses of the liq. ferri perchlor., combined with a sufficient amount of Epsom salts to prevent constipation, may be given. Local treatment is generally necessary in the shape of injection as already described, and the passage of a cold solid metal bougie every three or four days has an excellent effect. If granular urethritis is present, the topical application of nitrate of silver may be undertaken through an endoscope, but requires the greatest care, for fear of the subsequent formation of a stricture; chronic prostatitis and vesiculitis are dealt with by counter-irritation applied to the perineum, or possibly by sedatives, such as belladonna, administered in the form of suppositories.

Complications of Gonorrhœa.

These may be conveniently arranged under the following headings:

I. **Complications due to Direct Extension.**—*In the male*, the following may be described:

Balanitis is of frequent occurrence in patients with long foreskins (p. 1065). It is ordinarily due to pyogenic organisms, and not to gonococci. As a secondary result, inflammation of the lymphatics of the penis and inguinal bubo may follow.

Lacunar Abscess arises from infection of one or more of the lacunæ with the gonococcus or accompanying pyogenic organisms. A tense painful swelling forms along the floor of the urethra, which may project into the passage, and open either into the urethra, or externally, or both; in the latter case a penile fistula will result. The abscess should be opened as early as possible from without, so as to prevent the latter occurrence, which is often very difficult to treat. If a fistula forms within a quarter of an inch or so of the meatus—a common situation—it seldom heals of itself, but may in some cases be closed by an application of the electric cautery or a weak solution of nitrate of silver. If, however, it remains intractable, the fistula should be laid open into the meatus. When it occurs in the body of the penis, a plastic operation is usually required; it consists in paring the edges and dissecting up the skin on either side so as to bring it together in the median line.

Chordee results from inflammatory infiltration of the corpus spongiosum or one of the corpora cavernosa, so that when the penis becomes erect, it is bent downwards or to one side, owing to unequal distension of the infiltrated tissue. This condition is exceedingly painful, and most marked at night when the patient becomes warm in bed. It is best dealt with by applying cold to the part, or by administering bromide of potassium or opium at bedtime.

Inflammation of Cowper's Glands may in some cases give rise to deep suppuration in the perineum, with symptoms very similar to those of acute prostatitis. It is dealt with in the same way as the latter complaint.

Acute and Chronic Prostatitis (p. 1038).

Acute and Chronic Vesiculitis (p. 1091).

Epididymitis arises by extension along the vas, and has been already described at p. 1074. It rarely commences before the third week, and often not until the fifth or sixth, being perhaps caused by the injudicious use of injections, or by a blow or squeeze, especially if the scrotum is lax and pendulous.

Acute Cystitis (p. 1007).

In *the female* many complications arise by direct extension of the gonorrhœal inflammation along the urinary and genital tracts. The primary affection is most commonly a vulvo-vaginitis, and this may spread to the lining membrane of the uterus, or even to that of the Fallopian tubes (salpingitis), whilst ovaritis and pelvic peritonitis also occur.

II. **Complications arising from Direct Transmission of the Virus.**—**Gonorrhœal Proctitis** sometimes results in the female from infection by the discharge which escapes from the vulva, whilst in both sexes it may be due to unnatural practices. Considerable tenesmus is produced, accompanied by a thick muco-purulent discharge. It is treated by injecting lotions of acetate of lead and opium, or boric acid.

Gonorrhœal Rhinitis has also been seen in a few cases. It leads to an abundant discharge of pus, and should be treated by warm, soothing injections, followed after a time by dilute astringents.

Gonorrhœal Conjunctivitis occurs either in adults, when it is, as a rule, unilateral to start with, or in infants, when it is bilateral and due to infection during transit through the maternal passages (*ophthalmia neonatorum*). It is a remarkable fact that, although gonorrhœa is so very prevalent, such a small proportion of the patients suffer from conjunctival infection; it would appear, therefore, that not only must there be direct contact with the gonorrhœal poison, but in addition the mucous membrane must be in a receptive condition. In the adult variety it is ushered in by redness and irritability of the eye, followed quickly by a discharge which is at first mucous, but soon becomes purulent. The eyelids are red and swollen, the conjunctiva thickened and spongy (chemosis), and the discharge tends to accumulate within the conjunctival sac. If allowed to progress unchecked, the cornea may be injured by the inflammatory process, ulceration, or even necrosis, ensuing, and possibly general panophthalmitis. The first detail in the **Treatment** consists in protecting the opposite eye by means of what is known as a Buller's shield; a watch-glass is fixed in a piece of mackintosh over the eye, and kept in position by plaster. The affected conjunctiva must be unremittingly attended to night and day, so as to prevent accumulation of discharge; it is frequently irrigated with warm boric acid lotion, and every four hours the membrane is carefully washed, dried, and swabbed over with a solution of nitrate of silver (5 grains to 1 ounce). Between the applications, lint wrung out of iced boric acid lotion is kept over the eye. This plan of treatment is continued until the suppuration ceases, and then the silver salt is omitted, and simple astringents, such as chloride or sulphate of zinc, substituted.

In *infants* the disease often runs a rapid and severe course, and is very likely to lead to ulceration or sloughing of the cornea, a complication not uncommonly followed by escape of the lens and blindness. Crédé's preventive treatment should always be adopted for new-born children, viz., washing out the conjunctival sac with a weak solution of nitrate of silver or corrosive sublimate soon after birth. When suppuration occurs, the treatment to be adopted is practically identical with that detailed above, except that it is useless to attempt to limit the trouble to one eye.

III. **Complications resulting from General Absorption.**—**Gonorrhœal Sclerotitis**, or inflammation of the deep subconjunctival fibrous tissue, is a rare affection, arising quite independently of the disease just described. It is characterized by marked subconjunctival redness, the globe of the eye becoming distinctly tender. Local applications of atropine are required, and, if need be, leeches to the temples.

Gonorrhœal Affections of Joints are not uncommon sequelæ, arising usually in the subacute stage of the disease. They are met with either in the form of a synovitis with effusion, or as an arthritis, which may or may not suppurate, but usually ends in ankylosis. The former is probably due to the embolic transmission of gonococci alone, whilst in the latter pyogenic organisms are also conveyed to the articulation. For symptoms and treatment, see pp. 561 and 563.

Any muscular, tendinous, ligamentous, or aponeurotic tissues may become inflamed and painful during the course of an attack of gonorrhœa, but no special description is required.

Secondary abscesses, similar to those of pyæmia, are sometimes met with in cases of gonorrhœa, probably resulting from the diffusion of pyogenic organisms, and even general infection of a septicæmic nature has been described, leading to a fatal issue.

Soft Chancre.

A **Soft Chancre** results from a specific infection with some virus, the nature of which is at present undetermined, although there can be little doubt of its microbic origin. If artificially inoculated it runs a typical course. The spot becomes a distinctly red papule in twenty-four hours, whilst in two or three days a vesicle, surrounded by a zone of angry hyperæmia, is seen. The serum within the vesicle soon becomes turbid, and by the fourth or fifth day a fully-developed pustule is present, and as soon as the cuticle is lost, an ulcer forms with cleanly cut edges and a sharp, distinct outline. The chancre gradually increases in size up to a certain limit, and then if kept clean heals in about three weeks. Such sores may be met with on any part of the penis, but more especially on the prepuce and glans, or on the corona glandis, and are very painful and tender. The secretion is highly infective, and if inoculated elsewhere on the patient produces a typical sore, showing that the condition is purely local, and that no constitutional immunity results from its presence. Frequently several sores are present at the same time, whilst the discharge from one chancre is very likely to produce a similar affection on any cutaneous or mucous surface brought into contact with it; *e.g.*, it may spread from prepuce to glans, or *vice versâ*, or from one lip of the vulva to the other. It is a curious but well-authenticated fact that soft chancres are rarely seen on any part of the body other than the genital organs.

Various **Modifications** of the typical chancre are seen, usually resulting from neglect or carelessness on the part of the patient. Thus, if a long foreskin is present, the discharge may be retained behind it, and an extensive ulcerative balanitis occur, which may even result in the glans sloughing through the upper part of the prepuce, which drops beneath it. If the frænum is involved, smart hæmorrhage takes place from ulceration into a branch of the artery found in that structure. Where there is much inflammation, the base of the sore becomes indurated and infiltrated, somewhat resembling the Hunterian chancre. Not unfrequently syphilitic infection occurs at the same time as a soft chancre is contracted, or subsequently; the sore is then likely to run a longer course, does not heal, even if kept clean, and after a time presents the characteristic signs of syphilis.

In all cases the neighbouring **Lymphatic Glands** become enlarged and tender, and the process may terminate in suppuration, constituting a bubo. Three forms of this affection are described: (*a*) The *simple* or sympathetic bubo results from the absorption of ordinary pyogenic organisms from the abraded surface. The pus in this case, if inoculated elsewhere, may produce a pustule, but not a true chancre. The process is usually limited to the interior of the lymphatic glands. (*b*) The *virulent* bubo is one due to the absorption into the lymph stream, not only of pyogenic organisms, but also of the specific virus, so that when suppuration ensues, the pus, if inoculated, always produces a typical soft sore. In these cases the suppuration occurs not only within, but even more abundantly around the lymphatic glands (*periadenitis*), so that the skin becomes considerably undermined, and the wound produced by opening the abscess may take on the form of a huge soft chancre in the groin, in the centre of which may be seen the lymphatic gland only slightly enlarged. (*c*) The *bubon d'emblée* is the term applied by certain French authorities to an enlargement and affection of the glands without the existence of any sore on the penis; it is extremely doubtful whether this condition ever occurs.

The **Treatment** of soft chancre consists in keeping it clean, dusting its surface with iodoform, and covering it with lint dipped in lotio nigra or boric acid lotion, healing usually occurring in from ten to twenty days; where much balanitis exists it may be necessary to slit up the prepuce, but circumcision should not be undertaken until the sores have healed. The surface of the chancre may be treated with caustics, such as pure carbolic or nitric acid, and may perhaps heal quicker for such applications; but they need not be employed as a routine treatment, since soft chancres, if kept clean, are usually devoid of serious consequences. If the smell of iodoform is objected to, iodol or aristol may be substituted.

Buboes are treated in the early stages by keeping the patient at rest and applying hot fomentations, when resolution sometimes occurs. If suppuration ensues, the abscess should be incised vertically, so as to allow free exit to the pus, even when the patient is sitting, the cavity being subsequently dressed by stuffing it with gauze impregnated with iodoform. Some surgeons recommend that enlarged glands of this nature should be freely removed by dissection, but such is not required as a general rule.

Syphilis.

Syphilis is an infective venereal disease, resulting from inoculation with some specific virus, which has not yet been identified with certainty. Lüstgarten demonstrated an organism in the initial lesion which was supposed to be the bacillus of syphilis, but it was probably nothing more than the bacillus always present in smegma. The inability to transmit the disease to animals is one of the great difficulties in the way of a complete bacteriological examination.

Syphilis is characterized by the appearance of a primary sore, usually known as a hard chancre, which is followed in the course of a few weeks by evidences of general infection, referred mainly to the skin and mucous membranes, comprising the secondary stage. After a variable period, known as the intermediate stage, during which symptoms may be entirely absent, tertiary manifestations may show themselves in any and every part of the body.

Mode of Infection.—The great bulk of all cases of acquired syphilis is undoubtedly due to infection of the venereal organs arising from impure connection. Occasionally cases are met with in which the disease is transmitted by other means, the primary lesion being then often seated on some other part of the body (extragenital chancres); thus, a hard chancre may be found on the lips, as a result of drinking out of the same glass or smoking the same pipe as a syphilitic patient, or may even be acquired by kissing. The disease is not always equally infectious; in the primary stage the discharge derived from the chancre will alone convey the contagion; in the secondary period the virus is found in the blood of the individual, and hence all pathological exudations, as also the blood itself, will suffice to convey the disease. Pure secretions, *e.g.*, milk or urine, are free from infection, although if mixed with a serous exudation from abraded surfaces, as so frequently occurs in the case of the saliva, they at once become infective. The semen is probably an exception to the above rule, since, although the maternal passages may entirely escape, the ovum becomes diseased. It is usually held that in the tertiary stage the patient is no longer capable of transmitting the affection.

The syphilitic virus is exceedingly resistant to the action of antiseptics, and hence the risk of infection is very great, even though prompt measures are taken to destroy it. Thus, cases are on record in which an abraded surface was brought into contact with a syphilitic poison, and, although cauterized with fuming nitric acid within a few hours, the disease ran its ordinary course. In one case, however, under our observation, in which a student's finger was accidentally pricked with a bent broad needle, which a moment before had been inserted into the anterior chamber of a syphilitic patient suffering from a secondary suppurative iritis, nitric acid was applied within a quarter of an hour, and although a suspicious indurated spot formed six weeks later at the site of injury, no other evidences of syphilis have been observed, in spite of the fact that the individual had not previously suffered from the disease, and took no mercury.

One attack of syphilis usually confers immunity on the patient from further outbreaks of the disease, even if exposed to infection. This protection is, however, not always permanent, since well-authenticated cases have been observed of second attacks of syphilis, in which the primary lesion was followed by distinct signs of general infection.

Course of the Case.—The stage of **Incubation** lasts for a variable period, extending for two to six weeks; as a rule, however, evidences of induration of the sore can be detected about the third week. It is probable that long ere this the virus has entered the circulation, and hence removal or destruction of the local lesion has not the slightest influence upon the prognosis of the case, unless it can be undertaken immediately after infection. During this period nothing unusual is noted at the site of inoculation. If the infection is purely syphilitic, and the local sore merely a slight abrasion, it may heal completely in the course of a few days, and nothing further be noticed until the typical induration manifests itself; not unfrequently, however, the virus of the soft chancre is also present, and then the usual phenomena of this condition occur, and no syphilitic manifestations are seen till later.

I. **The Primary Stage** of syphilis is characterized by the development of a typical primary sore, associated with enlargement of the neighbouring lymphatic glands. It is usually situated on the base of the prepuce, close to the corona glandis, or on the frænum; in the female the inner aspects of the labia majora or nymphæ are the most common sites.

The primary sore does not always present the same appearances, although it is characterized by a variable amount of infiltration and induration. Should the superficial abrasion have healed, a localized growth of almost cartilaginous hardness forms in the cicatrix, closely adherent to and invading the cutis; but if it develops in a soft sore, the surface is ulcerated more or less deeply, and the base indurated. The following are the chief forms in which the chancre manifests itself. (*a*) The *desquamating papule* is a slightly elevated spot, which is extremely irritable, of a dusky colour, and free from ulceration. It is usually small, but hard, and its surface covered with epithelial scales. If exposed to friction, or to the irritation of retained discharges, ulceration is very likely to take place, and an ordinary Hunterian chancre will then develop. Unless this occurs, it may run its course unobserved, and thus a patient becomes syphilitic without being able to trace the time or source of infection. (*b*) The indurated, hard, or *Hunterian chancre* is that most commonly seen; it may result from the irritation of a papule, or be developed in association with a soft sore. It consists of a distinctly localized infiltration and induration of the submucous or subcutaneous tissues, giving rise to a lump which feels like a pellet of cartilage; or the induration may be more extensively diffused through the surrounding structures. In some cases there may be but little elevation of the growth, and the surface free from ulceration, constituting the variety known as the 'parchment induration' of Ricord, and not unfrequently seen on the glans penis. Where, however, the prepuce or body of the penis is involved, greater induration takes place, owing to the laxity of the connective tissue. When affecting the base of the prepuce, the induration tends to spread transversely, producing a collar-like mass, which on retraction of the part rolls back *en bloc*, in a characteristic manner. Examined microscopically, the new formation consists merely of a mass of round and spindle cells packed closely together, with a certain amount of intercellular fibrous tissue; giant cells are sometimes seen. The blood-supply of the part is very slight, a fact which explains the readiness with which ulceration occurs. It should not be forgotten that this new formation of tissue is an evidence that the system has already been influenced by the disease. Several chancres may be seen on the same individual if the infection occurs at one time, and it is possible that a patient could be infected at two different periods if only a short interval elapsed between the inoculations; but the disease is not generally auto-inoculable, and when once a hard chancre has developed on the under surface of the prepuce, the glans does not become infected from contact. Multiple chancres are always smaller than usual, and with less marked induration.

A **Urethral Chancre** is usually situated just within the lips of the meatus, constituting a sore the base of which becomes indurated. It may be felt as a hard nodule on grasping the urethra between the fingers, and gives rise to a thin serous discharge, often blood-stained. The orifice itself is sometimes the site of chancre, and the induration may completely encircle it. In all these cases a stricture may subsequently form.

Extragenital Chancres are often observed, perhaps most commonly on the lips, finger, and nipple; but, of course, any part of the body may become affected. These conditions are usually characterized by a greater amount of infiltration and less distinct and definite induration than in the forms met with on the genital organs; hence the swelling is more prominent and vascular, and if ulceration occurs there is a greater amount of discharge, which forms a thick scab over the surface. The neighbouring lymphatic glands are enlarged, and sometimes surrounded by infiltrated tissue.

This condition has often been mistaken for epithelioma, from which, however, it may be distinguished by the age of the patient, the characters of the sore, its sudden development, and the simultaneous enlargement of the glands. The course of the case in an extragenital chancre is generally more severe than when the primary lesion is in the usual situation, a fact explained by the disease often remaining unrecognised till secondary symptoms appear.

In surgeons or accoucheurs infection may occur on the fingers, usually starting by the side of the nail. It gives rise to an indolent sore, which becomes infiltrated and ulcerates, tending to spread under the matrix and along the semilunar fold. There is a good deal of discharge and pain, and the terminal phalanx becomes swollen and bulbous. The epicondyloid and axillary glands are enlarged as the case progresses, and the condition may even be mistaken for malignant disease.

Phagedena is a form of spreading ulceration, rarely met with at the present time, except in connection with venereal disease, and, according to most authorities, seldom apart from syphilis. It always attacks unhealthy and debilitated individuals, especially men with phimosis. The discharge is retained under the long foreskin, and, undergoing decomposition, gives rise to a spreading destructive inflammation of the prepuce and glans. Various organisms have been found in phagedena, but in all probability the condition is septic rather than infective in nature. The ulceration may extend with or without the formation of sloughs, and may lead to very considerable loss of tissue.

The **Treatment** consists in the relief of all tension by division of the foreskin if that structure has not been already destroyed, followed by prolonged immersion of the patient in a hot hip-bath, so that the toxines may be so diluted as to prevent any extension of the ulceration, and thus facilitate the natural processes of repair. If the patient cannot be kept for twelve to twenty-four hours in a warm bath, it will suffice to keep him immersed in warm water for two or three hours every day. In the intervals, the wound should be dressed with iodoform, and covered with lint dipped in lotio nigra. Under such circumstances, the surface of the sore cleans, and becomes covered with healthy granulations. The later treatment must be conducted as for primary syphilis, although the depressed condition of the general health must be attended to by administering tonics, and, if necessary, by a visit to the seaside. Should this plan of treatment be for any reason impracticable, the old-fashioned plan must be resorted to, viz., scraping the sore, and freely cauterizing the base with fuming nitric acid.

The **Lymphatic Glands**, which receive lymph from the region in which the sore is situated, become characteristically enlarged. They feel hard and shotty, moving freely under the skin, like bullets, pellets of cartilage, or almonds (hence the term 'amygdaloid' which has often been applied to them); they are usually quite painless. If a pure syphilitic infection occurs at the site of inoculation, there is no tendency for them to suppurate; but if the original sore is septic, or inoculated in addition with the virus of a soft chancre, an abscess often follows, one or more of the inguinal glands breaking down, and causing a red and brawny infiltration of the superjacent integument. After a time the skin gives way, and is often found extensively undermined.

Occasionally the lymphatic vessels extending from the sore to the glands become the seat of a chronic lymphangitis, and may be felt as hard cords beneath the skin. The dorsal lymphatic of the penis is frequently blocked in this way, and gives rise to solid or lymphatic œdema of the prepuce and glans. Should the chancre suppurate, an abscess may form in the course of the lymphatics.

The **duration** of the primary sore varies in different cases, and depends in great measure on whether treatment is adopted early or late. If the case comes under observation during the first six weeks, and a mercurial course is at once started, the chancre heals, and the induration usually disappears in from six to eight weeks. The glands in the groin, however, remain enlarged for some time. The longer the case is left untreated, the more slowly does the induration disappear. If no mercury is administered at all, the induration may last for twelve months or more, and then slowly passes off. From an uncomplicated syphilitic sore, but little scar results, although a well-marked cicatrix may follow a soft or septic chancre.

II. **Secondary Syphilis**.—In the secondary stage, the virus is diffused generally throughout the body by means of the blood, which is itself infective. A certain amount of constitutional disturbance may be present, the patient feeling 'seedy' and out of sorts, whilst in some cases marked febrile phenomena and headache have been noted. The chief secondary manifestations consist in the appearance of various forms of rash on the skin and mucous membranes, associated with a general enlargement of the lymphatic glands, sore throat, mucous tubercles and condylomata, loss of hair, and other less common phenomena, and these usually show themselves in from seven to nine weeks from the time of inoculation, although they may be delayed to a much later date. Their intensity also varies considerably, the phenomena being sometimes scarcely evident, and at others very marked. They are also influenced greatly by the period at which the administration of mercury commences; the earlier the drug is given, the less obvious are the secondary phenomena. It will thus be seen that there is a considerable analogy between syphilis and the more acute forms of infective disease, known as the exanthemata, only that the whole process is spread over a much longer period.

The **Cutaneous Eruptions** of secondary syphilis are chiefly characterized by the fact that, although any form of rash may be simulated, no specially distinctive variety is originated. Moreover, in the same individual the eruption is not always of the same character throughout, several distinct types developing in separate parts of the body (*polymorphism*). The rash is usually more or less symmetrical, the colour in the early stages being a dusky red, resembling that of raw ham, whilst later on it becomes of a more coppery hue; occasionally, however, it may be a bright rosy red. Syphilitic rashes do not completely fade on pressure, but leave a brown stain, and give rise to but little irritation or itching; they always tend to progress from the simpler types, due to hyperæmia, to the more serious, in which infiltration and overgrowth are evident.

In the simplest form, a mere hyperæmia is present, sometimes appearing as a dusky mottling of the skin (*roseolous* syphilide), which quickly fades, or may persist whilst other types are developing. If distinct papillæ become infiltrated and hyperæmic, a *papular* syphilide is said to be present; such may become either vesicular or pustular, constituting the *vesicular* or *pustular* syphilides; the latter change is uncommon, and only appears in bad cases or in debilitated patients. Another form of eruption is the *squamous* syphilide, characterized by patches of hyperæmia and infiltration, combined with superficial desquamation. It is usually bilateral, and, unlike simple psoriasis, tends to affect the flexor rather than the extensor surfaces. In the latter stages, distinct nodules or tubercles are produced in the skin, which may even run on to ulceration (*tubercular* syphilide).

As to the *situation* of the rash, the roseola is usually limited to the abdomen, whilst the other forms are often widely scattered over the trunk and extremities, tending, however, to involve the flexor more than the extensor surfaces of the limbs. A somewhat characteristic phenomenon is the appearance of a papular rash on the forehead, sometimes known as the *corona veneris*.

The **Mucous Membranes** may be affected in much the same way as the skin. The fauces become red and congested, the hyperæmic area being abruptly limited, and semicircular in outline; symmetrical ulceration usually follows, originating near the anterior pillars of the fauces, and spreading thence to the tonsils and along the soft palate to the uvula. These ulcers are shallow, have sharply-cut edges, and present a characteristic greyish appearance, constituting what is known as a 'snail-track' ulcer. The secondary sore throat rarely results in extensive loss of substance, and hence pharyngeal stenosis is not common at this period of the disease. Smoking undoubtedly aggravates these conditions. Concurrently with these manifestations in the fauces a number of bare patches from loss of epithelium may be seen on the dorsum of the tongue, or several small superficial, but very painful, ulcers may develop on the inside of the cheeks or lips.

Mucous tubercles and condylomata are somewhat similar affections, though more pronounced, arising in the secondary stage in connection with mucous membranes and soft and moist parts of the skin. **Mucous Tubercles** consist of slightly-raised patches of enlarged and infiltrated papillæ, white in appearance from the superficial epithelium becoming sodden, and which may progress subsequently to actual ulceration. Examined microscopically, the papillæ are found to be definitely enlarged, and the epithelium heaped up over them. They are most commonly observed at the corners of the mouth, on the inner aspect of the cheeks, the side of the tongue (often due there to the irritation of rough teeth), or the margin of the anus; in the last-named situation they are usually symmetrical, one side being infected from the other. They are also not at all uncommonly found between the toes, and the resulting ulcers then become exceedingly offensive from septic contamination. **Condylomata** are similarly the result of overgrowth of the papillæ, differing from mucous tubercles merely in the extent to which this has been carried. They consist of definite wart-like masses, which may attain a great size, constituting a cauliflower-like growth. They are most commonly seen about the anus or vulva, in the former situation being often mistaken by the patient for piles; they give rise to an abundant, highly infective discharge. A similar condition is sometimes met with on the dorsum of the tongue, and is then known as 'Hutchinson's wart.'

The **Lymphatic Glands** are usually enlarged throughout the body during this period of the disease, being felt as round, hard, shotty swellings beneath the skin. The extent of the glandular complication is possibly a measure of the degree of virulence of the affection. The condition of the nuchal and epicondyloid glands should always be ascertained in suspicious cases, since, if no obvious local cause exists for their enlargement, such as pediculi in the head or an injury to the hands, syphilis is very probably present.

Syphilitic Alopecia.—The hair becomes dull and lustreless, and either comes out in patches from the scalp, eyebrows, beard, etc., or there is a general 'thinning.' The follicles, however, are not destroyed, and after a time the hair will grow again as before.

Later secondary manifestations consist of flying pains in the bones (osteocopic), iritis, and various nervous lesions, whilst periosteal nodes may form on the tibiæ and other bones, or a symmetrical chronic effusion develop within the synovial membrane of joints.

Syphilitic Iritis is characterized by pain in the eye, generally referred to the supra-orbital nerve, together with some interference with vision, and possibly a little lachrymation and photophobia. On examination of the eye, considerable hyperæmia of the conjunctiva, and especially of the ciliary vessels, is noted, constituting a bright-red circular zone immediately surrounding the cornea. The iris is lustreless, and its definition somewhat blurred. Its colour is changed, a blue iris becoming greenish-yellow from the presence of lymph. The pupil is diminished in size, and perhaps irregular; its movements are always considerably hampered, and sometimes entirely prevented by the formation of adhesions either to the back of the cornea (anterior synechiæ) or to the lens capsule (posterior synechiæ). Occasionally small yellowish nodules are seen on its surface, consisting of plastic lymph.

The **Duration** of the secondary stage varies considerably in different cases, and is largely influenced by the character of the treatment and the period at which it is commenced. The sooner the patient is brought judiciously under the influence of mercury, the less severe the secondary phenomena, whilst cases in which treatment has been delayed are likely to be much more troublesome. Hence the disease is often of an aggravated type when following extragenital chancres, as also in women, by whom the primary lesion often passes unnoticed and untreated. When treatment is commenced within four or five weeks of infection, the secondary stage is slight, and all traces of its existence may pass off in two months or less; if mercury is not administered until the cutaneous eruption has appeared, this stage is likely to last much longer. The condition of the patient's health is an important factor, as also the previous habits, particularly as to temperance, since syphilis always follows a more aggravated course in the weakly and the dissipated. Even under the best circumstances, the patient is liable to outbreaks of the affection within the first twelve months. *Relapses* are by no means uncommon, being usually due to intermissions in the treatment. The rash which appears under these circumstances is often of a more characteristic type, the papules being grouped into rounded or corymbose figures.

III. The **Intermediate or late Secondary Stage** comprises a group of symptoms which form a link between those already described and the tertiary phenomena; and indeed no distinct limits to this period can be defined, nor need it appear at all if the patient's general health is good, and the treatment has been regularly carried out. Some of the secondary manifestations, especially those of the bones and joints, may persist through this period, whilst even if they have disappeared, the patient is liable to suffer from 'reminders' in the shape of various cutaneous affections, and perhaps epididymitis. Deep lesions of the eye (choroido-retinitis), and of the central nervous system (syphilitic monoplegia), are not uncommon, the latter usually arising from anæmia of the cerebral centres due to a syphilitic endarteritis (p. 243). The principal cutaneous affection is the so-called 'syphilitic psoriasis.' A squamous syphilide is often seen in the secondary stage, but is then symmetrical and readily influenced by mercury. In this intermediate period, the lesion may be bilateral or limited to one side, according to whether it appears early or late. In the former there is a considerable tendency to proliferation of the epithelium, together with deep cracks and fissures; in the latter there is less epithelial overgrowth, but the edges are often distinctly serpiginous in outline, and there is an infiltrated border.

Rupia and **Ecthyma** are both met with in this stage of the disease. They are characterized by an infiltration of the skin, which progresses to ulceration. In rupia the discharge forms a distinct scab on the surface, which increases in thickness by the deposit of successive layers one under the other, each being somewhat larger than the one which precedes it; hence a scab shaped like a limpet-shell is produced, resting on an inflamed and hyperæmic base; any part of the body may be affected in this way. In ecthyma no scab forms over the ulcerated surface, or, if formed, it readily comes away, leaving exposed a hollow, punched-out sore, surrounded by an area of vivid congestion.

Under appropriate treatment these conditions disappear, but leave depressed, whitish cicatrices, often surrounded by pigmentation.

A somewhat unusual intermediate manifestation is a subacute symmetrical epididymitis, in which the cord also becomes thickened, enlarged, and tender (p. 1077).

IV. **Tertiary Syphilis.**—The phenomena occurring in this stage may appear within six months of the infection, or not for twenty or thirty years. They are mainly characterized by infiltration and overgrowth of the connective tissues of the body. Such may occur in one or many places, and may be diffuse or localized. In the former case the organ or part affected becomes enlarged, hard, and sclerosed, and unless the condition is treated promptly, the normal tissue of the part may entirely disappear, being replaced by fibro-cicatricial tissue. If, however, the process is localized, a *gumma* is formed.

Any tissue in the body may be the seat of a gummatous deposit, which apparently arises without any definite cause, although occasionally its onset may be determined by an injury. The connective tissue of the involved area becomes the seat of a round-celled infiltration, the cells being derived partly from proliferation of the connective tissue, and partly from leucocytes. This gradually increases in amount, the normal tissue of the part disappearing before it. Very few vessels penetrate into the mass thus formed, which otherwise somewhat resembles granulation tissue. As the process extends peripherally, the older portion is gradually transformed into cicatricial tissue, and, finally, owing mainly to the compression of the vessels by its contraction, and partly to a concurrent syphilitic affection of the tunica intima of the nutrient arteries (p. 243), the blood-supply of the centre of the gumma fails, and the tissue dies. In this stage a gumma consists of a central, whitish-yellow slough, devoid of vessels, and comprising the oldest portions of the growth in a condition of fatty degeneration and necrosis; surrounding this is a zone of loose vascular fibro-cicatricial tissue, whilst the periphery of the tumour is constituted by a round-celled hyperæmic infiltration of the normal tissues of the part. Under appropriate treatment, the whole of this new formation may disappear, being replaced by a fibrous cicatrix; but not unfrequently the central portion breaks down into a gummy, semi-purulent fluid, which finds its way to the surface and is discharged. Where the necrosed tissue is extensive in amount, a portion of it may remain adherent to the surrounding tissues after ulceration has taken place, appearing at the bottom of the wound as a mass, somewhat resembling a piece of wet wash-leather. Under exceptional circumstances the central slough may become encysted by the formation of a fibrous capsule, and calcification of the centre may even occur; this is stated to be most frequently found in the brain, testis, and liver.

Clinically, the appearances vary according to whether the gumma is cutaneous or subcutaneous.

Cutaneous gummata are very frequently observed in tertiary syphilis, especially in the earlier stages. They occur as dusky-red tuberculated nodules of firm consistency, and but slightly painful. Many such growths are often grouped together at one spot, and when ulceration has occurred, they produce by their confluence sores with a rounded or serpiginous outline. Considerable destruction of tissue may follow, but, as a rule, they are readily cured, giving rise to depressed white cicatrices, surrounded by pigmentation.

Occasionally a diffuse infiltration of the skin is met with in this stage, appearing as a red hyperæmic area with a rounded or serpiginous border, and not at all unlike lupus in appearance. It is readily amenable to treatment, and runs a much more rapid course than lupus; the edge is usually thickened to the same extent all round, and there is but little tendency to the formation of outlying nodules. A cicatrix not uncommonly results, even if ulceration has not taken place.

Subcutaneous gummata are characterized by the formation of a firm nodule, which gradually increases in size, and sooner or later tends to travel towards the surface; the centre of the tumour becomes elastic and fluctuating; a certain amount of pain and tenderness is noticed, and when the skin is affected, it becomes dusky and even œdematous. Ulceration follows, and the contents of the gumma are thus evacuated. The sore produced is deep, the edges being sharply cut, and perhaps undermined; the base of the ulcer consists of granulation tissue, although it is sometimes covered by the characteristic slough.

The peculiar features of tertiary syphilis, as it affects special regions, have been described under the appropriate headings: *vide* syphilitic diseases of arteries (p. 243); of lymphatic glands (p. 311); of muscles (p. 348); of bones (p. 537); of joints (p. 578); of the lips (p. 661); of the pharynx (p. 730); of the tongue (p. 704); of the larynx (p. 767); of the rectum (p. 966); of the testis (p. 1077). The symptoms arising from gumma of the brain have also been alluded to at p. 649, but the general relation of syphilis to the nervous system has been purposely omitted, since it belongs rather to the physician than to the surgeon.

The **Prognosis** of syphilis is good if the patient comes under treatment at a sufficiently early stage, and if he has no idiosyncrasy which prevents the administration of mercury and iodide of potassium. In persons suffering from extragenital chancres, which are not recognised till late, the disease often runs a more than usually severe course. The general health of the patient, and perhaps a peculiar predisposition, may influence the evolution of the case considerably, whilst the co-existence of tubercular disease may render the prognosis peculiarly unfavourable, and especially when the disease is inherited. The character of the rash, and the extent of the general glandular enlargement in the secondary stage, may perhaps give some indication of the gravity of the case; where the eruption is but slightly marked, the other symptoms are usually mild, whilst a pustular eruption is almost always of grave import. Death is rarely produced by any of the secondary manifestations, but may occur in the tertiary stage, when important viscera, such as the brain, spinal cord, liver, etc., are involved.

As to the **Curability** of syphilis, the general opinion held at present is that, if the disease is seen early, and treated satisfactorily, the patient will in all probability never suffer from any further manifestations after the secondary symptoms have disappeared. A cure can, however, never be definitely promised, since, should the general health of the patient become impaired, characteristic syphilitic phenomena may make themselves evident even thirty or forty years after the primary lesion. There is also no doubt that certain cases are to be looked on as absolutely incurable, owing probably to the fact that they were not brought under treatment until tertiary phenomena were present; such are usually seen amongst females.

The **Treatment** of syphilis consists in the administration of mercury during the primary and secondary stages, and of iodide of potassium, with or without mercury, in the late secondary and tertiary periods.

Many different methods have been suggested for the *administration of mercury*, in order that the patient may derive the greatest amount of benefit from the drug with the minimum of inconvenience. (*a*) It is usually given *by the mouth*, either in the form of pills composed of grey powder (grs. i.—iii., t.d.s.), or of the green iodide (gr. ½—1, t.d.s.), or as a mixture containing a solution of corrosive sublimate. The last method is distinctly objectionable, inasmuch as its prolonged use in sufficient doses disturbs the digestion. Grey powder is perhaps the best means of giving the drug; the patient should commence with 2 grains, given three times a day, or in some cases 1½ grains four times a day, combined with a little extract of opium or pulv. ipecac. co. if any tendency to diarrhœa results; but this addition is not always needed. This should be cautiously continued until all prominent signs of the disease have disappeared, and then the dose is gradually reduced. (*b*) *Inunction* of ung. hydrargyri is also frequently adopted, and with great success, inasmuch as it is less likely to cause digestive derangements. If the ordinary officinal ointment is employed, a portion as large as a hazel-nut is rubbed into the groin or axilla nightly, the part being washed the following morning, and not used again for this purpose for three or four days; if lanoline is employed in the preparation of the ointment, a somewhat smaller amount is required. Possibly this is one of the best ways of bringing the patient rapidly under the influence of the drug. (*c*) *Mercurial vapour baths* may be advantageously employed where the cutaneous eruption is very extensive. The patient sits naked on a cane-seated chair, and covered with a blanket or specially constructed cloak reaching from the neck to the ground, and not touching the body; 20 or 30 grains of calomel are placed on a metal plate surrounded by a trough containing about 1 ounce of water. The water is boiled and the calomel sublimed by means of a spirit-lamp placed under the chair. In about twenty minutes all the calomel will be volatilized, and deposited in part upon the skin of the patient, who perspires freely during the process. He then gets into bed between warm blankets, without wiping the skin. This treatment may be combined with medication by the mouth. (*d*) Mercury is sometimes administered by subcutaneous injections, in the form of the perchloride, ½ grain or less being injected once or twice a week into the substance of the gluteus maximus. A little thickening of the site of injection results, but quickly passes away, and suppuration scarcely ever follows.

During the course of mercury, the patient's general health and habits must be carefully regulated, all excesses in drink and diet being forbidden, and strict instructions given as to keeping the teeth and gums clean. To minimize the risk of throat and mouth trouble, it is wise to stop all smoking for at least six months. The dose required varies in different individuals, being increased in robust people, and diminished in those who are weak or unhealthy. It should always be pushed until mild physiological effects are produced in the shape of slight tenderness of the gums, but salivation should always be avoided. Full doses are usually required for four or five months, followed by a milder course which should extend till the end of the first year.

Although symptoms of excessive mercurialism are generally induced by overdoses of the drug, yet in some people a very small dose suffices to produce severe effects; the existence of this idiosyncrasy must never be forgotten, and large doses should never be administered without first ascertaining whether or not the patient can tolerate them. When mercury is producing toxic effects, the gums become soft and spongy, and bleed readily on pressure. Salivation follows, and even acute glossitis may be produced, whilst the breath is always exceedingly offensive. In worse cases the teeth become loose, and even necrosis of the alveoli has been known. Derangement of the digestion, in the shape of colicky pain and diarrhœa, are also observed. The treatment of this condition consists in suspending the administration of the drug, and giving a sharp saline purge, whilst the spongy state of the gums is remedied by the use of an alum or chlorate of potash mouth-wash, and of the latter salt also internally.

Iodide of potassium is essential in the treatment of the tertiary and intermediate stages, combined possibly with small doses of liq. hyd. perchlor. (♏ xv. to ʒi.). The dose should not exceed 5 grains to start with, and is gradually increased until in some cases 1 drachm four times a day has been reached. A feeling of depression and sinking at the hypogastrium is often produced, but may be alleviated by the addition of Sal Volatile or carbonate of ammonia, as suggested by Sir James Paget. Symptoms of coryza may follow, and an acneiform eruption over the shoulders and face, which, however, often disappears on increasing the dose. Sometimes a vesicular, or even bullous, rash is caused by this drug. When colossal doses are given, bicarbonate of soda or potash must be combined with it, in order to prevent its decomposition by the gastric juice, and plenty of water should always be taken with it or immediately after to assist in its dilution and facilitate its absorption. The iodides of sodium and ammonium are sometimes substituted for the potassium salt, on the plea that they give rise to less depression.

Other drugs, such as sarsaparilla and iron, are often combined with iodide of potassium in the later stages of the disease, and may be useful.

The **Local Treatment** of syphilitic sores consists mainly in the application of various preparations of mercury. The *primary chancre* is usually treated with lotio nigra on lint, iodoform being sometimes employed if septic ulceration is present. *Mucous tubercles* in the neighbourhood of the anus or vulva, or between the toes, are best dealt with by keeping them scrupulously clean and dusting them over with powdered calomel, or by the application of calomel ointment, a piece of lint being inserted between opposing surfaces to keep them from rubbing one against the other. Secondary ulceration of the *throat* does not usually call for local treatment, as it soon disappears under the influence of mercury. A mercurial gargle may, however, be employed, or in bad cases calomel may be placed on a hot copper coin, and its vapour inhaled. *Superficial gummatous ulcers* are treated by removing the scabs, and applying some form of mercurial ointment. A determined attempt should be made to keep deep gummatous ulcers in an aseptic condition, since the advent of sepsis to such sores, especially if they are connected with bones, makes a marked difference in their progress. In neglected cases the wound may become exceedingly foul, and may even give rise to septic absorption, characterized by a hectic temperature, whilst amyloid degeneration of the viscera has even been observed. When gummata come to the surface and point, they should be opened with the same precautions as are adopted in the case of an abscess, and either dressed antiseptically, or their cavity stuffed with lint or gauze soaked in lotio nigra.

Inherited or Congenital Syphilis.

Syphilis may be conveyed to the ovum either by direct transmission from the father or mother alone, or both parents may be tainted with the disease. Occasionally the mother acquires syphilis during pregnancy, and in such cases the fœtus also becomes affected. In those instances where the ovum is infected from the father, whilst the mother has escaped, the latter becomes in measure protected, so that, if the child is put to her breast, she does not contract the disease, even though there are ulcerating lesions on the child's gums and lips, whilst healthy wet-nurses are invariably infected (*Colles's Law*). Whether the immunity is permanent or not is still a matter of uncertainty, and even the inviolability of this law has recently been called in question.

The length of time during which the patients retain the power of transmitting the disease to the fœtus is an exceedingly difficult point to determine, and one which is constantly coming before the practitioner, who is asked to decide at what period it is safe for a syphilitic patient to marry. The rule of practice generally followed is that no one suffering from syphilis should be allowed to marry until he or she has been free from all symptoms for at least a twelvemonth, and even then it is advisable that a mild course of mercury should be given for about three months shortly before marriage.

A syphilitic fœtus often fails to arrive at maturity, the mother miscarrying at the end of six or seven months. This is probably due to a syphilitic affection of the endometrium, especially involving that portion of the decidua which enters into the formation of the placenta. The circulation and nutrition of the fœtus are thereby impaired, so that it is usually born not only dead, but in many cases macerated, and partially decomposing. This may be repeated for several pregnancies, and then a living child is produced. In many cases, however, a living child may be born at full time at the end of the first pregnancy, in spite of the syphilitic infection of the parents.

At birth the child often appears healthy and well nourished, but is sometimes small and imperfectly developed. The first definite symptoms of the disease manifest themselves at a variable time, extending from three weeks to three months after birth; the child becomes thin and emaciated; the skin, which hangs in wrinkles over the body, changes to a dull earthy colour, whilst the features look pinched and wizened, like those of an old man. Marked anæmia is always present, and tends to persist for a considerable time. Speaking generally, the symptoms of inherited syphilis are similar to those of the acquired disease, except that the primary lesion is absent. Thus, during the first year of life the child develops various cutaneous eruptions, mucous tubercles, and superficial ulcerations of the mucous membranes. A dusky red roseola may first be noticed, but does not last long. This is usually followed by the appearance of mucous tubercles at the angles of the mouth, in the nose, and around the anus, as also in the moist folds of the groin, and between the scrotum and thigh. The sores on the lips are sometimes very marked, giving rise to ulcerated surfaces, which, by their subsequent cicatrization, leave radiating scars (or rhagades), especially about the angles of the mouth. Other cutaneous affections, such as squamous syphilides of the soles of the feet, together with papular syphilides of the body, and a bullous eruption becoming pustular (pemphigus), are also frequently observed, the last mentioned, however, only occurring in debilitated infants. A catarrhal rhinitis is a very constant manifestation, giving rise to obstructed nasal respiration, or *snuffles*. This affection is often protracted, going on to ulceration and destruction of the nasal bones and cartilages; their subsequent development is thus prevented or impaired, and hence the bridge of the nose remains depressed and sunken, even when adult life is reached.

Many infants during the first year of life die from malnutrition or marasmus; but if properly treated a considerable proportion will regain their health within six or eight months, all the manifestations described above disappearing, although their scars may remain.

FIG. 371.—TEETH IN INHERITED SYPHILIS (DIAGRAMMATIC).

After the first year, any of the tertiary phenomena which appear in acquired syphilis may develop, but, in addition to these, peculiar manifestations may be produced, especially affecting the teeth, bones, and cornea.

The **Teeth** in inherited syphilis are often very characteristic. The temporary teeth usually appear early, are discoloured, and crumble away. The permanent teeth may be sound and healthy, but are not uncommonly deformed. The central incisors of the upper jaw are those most particularly affected, but the upper laterals and the incisors of the lower jaw may also be involved. Instead of being broader at the crown than at the root, they diminish in size from root to crown, being often stunted, and separated from one another by interspaces (Fig. 371). The angles of the crown are rounded off, and a distinct notch, forming a large segment of a small circle, occupies the centre. The enamel is often imperfectly developed, and hence they decay early. Occasionally they may be shaped like a screw-driver, narrowing from root to crown, and with a straight free border. The notched and stunted teeth described above are sometimes known as 'Hutchinson's teeth.'

The **Bone** affections observed in inherited syphilis have been already described at p. 540.

Interstitial Keratitis, or diffuse inflammation of the cornea, usually occurs about the age of puberty, or earlier. It is limited at first to one eye, but the other is almost certain to be similarly affected at a later date. It commences as a diffuse haziness of the cornea, which looks something like ground glass, associated with hyperæmia of the ciliary region. Red areas, or 'salmon patches,' may be produced in the midst of the opacity, due to a new formation of minute vessels. There is no tendency to ulceration, but in protracted cases the anterior part of the eye may bulge forwards, constituting a condition known as 'anterior staphyloma.' The inflammation may spread to the iris and ciliary body. With suitable precautions the cases usually do well, although treatment may be necessary for several years.

The **Treatment** of inherited syphilis should commence as soon as definite manifestations of the disease are present. The general health must be attended to, and if the mother is unable to nurse the child, it must be brought up by hand; on no account must it be given to a wet-nurse. Mercury is best administered by anointing the under surface of the flannel belly-band with mercurial ointment, or the same preparation may be rubbed into the soles of the feet every night. This should be continued until all secondary phenomena have disappeared, advisably until the child is a year old. Cod liver oil may also be ordered with advantage in some cases. When tertiary symptoms appear, iodide of potassium and mercury may be given in a mixture, in suitable doses.

The local treatment of external lesions is conducted according to the rules laid down for the acquired type of the disease.

CHAPTER XXXIX.

PLASTIC SURGERY.

UNDER the title **Plastic Surgery**, we include all operative proceedings of a conservative nature designed to remedy superficial deformities or defects, whether due to congenital malformation, injury, or disease.

The **Objects** for which plastic surgery is mainly employed are as follows: (*a*) The closure of fissures or apertures, congenital or otherwise, such as hare-lip and cleft palate, or artificial anus, recto-vaginal and recto-vesical fistulæ, urinary fistulæ, etc. (*b*) The remedying of the results of extensive injuries, *e.g.*, burns, scalds, or severe destruction of tissue, as from sloughing cellulitis, cancrum oris, etc. In such cases, if the wound heals, cicatricial bands may cause such contraction as to limit and impair movement, especially if the cicatrix be situated in the flexure of a joint. Occasionally the wound may be so extensive that complete healing is impossible; cicatricial contraction of the floor leads to anæmia of the surface granulations, and hence not only is the process of repair limited, but portions which have already healed break down again; an open wound therefore persists which can only be closed by some form of operative treatment. (*c*) The restoration of integument which has been sacrificed in the removal of disease, *e.g.*, the formation of a new lip after its excision for epithelioma.

The **Methods** employed are so numerous and varied that in this work we have merely indicated the best plans to adopt in particular instances, and we now propose to enunciate the principles which underlie them. For practical purposes they may be divided under two main classes: (1) That of moving flaps of skin without completely detaching them; and (2) by their complete detachment and transplantation.

I. The repair of the defect is brought about by **Shifting or Gliding of Skin** (**Glissement**) from one part to another, after freeing it from its connections with the subcutaneous tissues, but not entirely detaching it from the neighbouring skin. This may be accomplished in the following ways:

(i.) By simply undercutting the margins of the wound to such an extent as to allow them to be drawn together without tension. Thus, in hare-lip, both segments of the lip should be freed from the maxillæ as the first stage of the operation; again, in cases where much skin has been removed in connection with tumours, as in scirrhus mammæ, it may suffice to undercut the neighbouring skin and draw the flaps together, using deep button sutures to make traction from points situated some distance from the wound, and thus relieve the strain upon the sutures which are applied to unite the edges.

(ii.) By making incisions parallel to the margins of the defect, with or without undercutting, the lateral wounds, which are not much more than half the size of the median defect, being left to heal by granulation. This plan is mainly used in dealing with cases of cleft palate, where lateral incisions are made not only to strip off the muco-periosteal flaps from the bone, but also for the relief of tension.

(iii.) By prolonging one or more of the incisions used in the removal of the growth, or of the margins of the defect, in a straight or curved direction, a flap can be dissected up, and drawn over so as to cover the denuded surface. Thus, a triangular defect can be repaired as indicated in Fig. 372, A and B, where *a b c* indicates the denuded surface, and *c d* the extra incision, the flap *a c d* being raised by undercutting, and drawn over so as to cover the raw surface.

Such operations are rarely required, since oval incisions are almost always used for the removal of tumours, the margins of the defect being thus easily approximated.

(iv.) By the detachment of *pedunculated flaps*, which merely need to be twisted into the new position, and then fixed there permanently, or may for a time remain attached by the pedicle, which is totally divided at a subsequent period. Many different plans have been adopted, of which the following are the chief:

(*a*) The flap is obtained from integument in convenient contiguity to the defect, and is turned or twisted into its new position and there fixed, the pedicle being subsequently divided or not, as the case may be. This is perhaps the method most commonly employed, and is well illustrated by the Indian operation of rhinoplasty (p. 682).

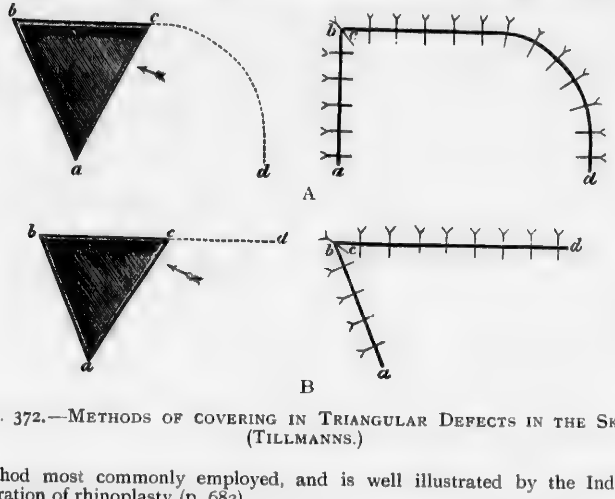


FIG. 372.—METHODS OF COVERING IN TRIANGULAR DEFECTS IN THE SKIN. (TILLMANNS.)

(*b*) The flap is obtained from some distant region of the body, which is maintained in close apposition to the defective part by some mechanical contrivance until the nourishment gained by the flap from its new connections is sufficient to allow the pedicle to be divided. In the Tagliacozzian operation for rhinoplasty (p. 683), the arm is fixed over the face and head in such a way that a flap can be raised from the upper arm and fixed over the nasal defect. Defects in the arm can similarly be covered in by flaps from the abdomen without difficulty if the arm is carefully fixed to the side.

(*c*) Fistulous communications with viscera, *e.g.*, artificial anus, or losses of substance, as in ectopia vesicæ, may be dealt with by the use of *reversed flaps*, as practised by the late Professor John Wood. A flap of skin is turned in, and exactly fitted and sutured to the freshened walls of the defect, its raw surface looking outwards, and then another flap is dissected up, and placed with its raw surface in contact with that of the former and covering exactly the cutaneous defect, the two lateral gaps being closed with sutures.

(*d*) Mr. Croft, of St. Thomas's Hospital, has suggested a plan of dealing with large callous wounds by raising one or more bridges of skin in the neighbourhood, passing protective beneath them to prevent them reuniting, and allowing them to remain *in situ* until all shrinkage has ceased, and until they have become succulent by the development of granulation tissue on the under surface. One end is then divided, and the flap twisted over the raw surface and sutured there, both parts being freed from the granulations which have developed.

II. The second method employed in plastic surgery is that of **Transplantation** of tissue. This has been utilized both for superficial and deep defects, and we have incidentally mentioned several such processes throughout the work. Thus, in Chapter III. we have described the various methods of transplantation of cutaneous tissues employed by surgeons, and we need only recapitulate them here, viz.:

(i.) Reverdin's original plan of placing minute fragments of cuticle on granulating surfaces.

(ii.) Thiersch's plan of cutting large slices of cuticle with a razor, and implanting them on granulating or raw surfaces.

(iii.) The whole thickness of the skin may be removed, and utilized for covering defects. After depriving it of all fat and subcutaneous tissue, the skin is placed on the raw surface (from which granulations, if present, must be scraped), and stitched *in situ*.

(iv.) Skin and mucous membrane may be removed from animals, and similarly employed.

Since these methods (especially the second and third) have been more fully understood, and the technique of such operations simplified, a much greater measure of success has followed them, with the result that operations by the method of *glissement* are less common than in former days.

The transplantation of bones, nerves, and tendons from animals to man has also been frequently adopted, but not with much success.

General Principles to be observed.—If complete success is to attend plastic surgery, the greatest care must be given to the smallest details, otherwise failure is certain. The following points must be especially noted:

1. Complete asepsis is a *sine quâ non* in order to gain healing by first intention, and necessarily suppuration must be avoided if deformity is not to result. Strong antiseptics, however, should never be employed, since they tend to irritate the parts. The instruments may be purified in carbolic lotion (1 in 20), but should be washed subsequently in boric acid lotion or a weak solution of sublimate.

2. Gentleness in manipulation is a second essential, so that the edges and substance of the flaps are not bruised. Only the sharpest knives should be used, and the flaps must never be grasped by forceps. Great care will also be needed whilst sponging the parts, not to damage the edges.

3. In paring the margins of openings or fistulæ, no excess of tissue should be removed, but in cutting flaps allowance must be made for the subsequent shrinkage always met with; as a general rule, they should be made half as large again as needed.

4. The flaps must be so cut that the base shall include sufficient vessels and nerves to maintain vitality and sensation, and the pedicle should not be overtwisted, or strangulation will result. It is often possible to round off the termination of one of the incisions so as to relax tension. The edges of the flaps, too, must be evenly cut and not bevelled, or there may be difficulty in bringing them into exact apposition.

5. During the operation the flaps should be kept warm and moist.

6. All cicatricial tissue or skin of low vitality should be avoided, if possible, in plastic work.

7. Absolute hæmostasis must be obtained before suturing up the flaps; this is best accomplished by the pressure of hot sponges, or by torsion or forcipressure, ligatures being avoided. It may be well to delay a little towards the close of the operation, so as to allow a film of blood-clot to form over the surface.

8. The most accurate adaptation of the parts must be obtained by non-irritating sutures, such as fine silver-wire, silkworm-gut, fine catgut, or horse-hair; no tension is permissible, and as much surface contact as possible must be obtained by means of deep or buried sutures.

9. Drainage must be arranged for, if necessary, but drainage-tubes should not, as a rule, be employed.

10. The flaps must be well supported from without by appropriate dressings and bandages, but without undue pressure. In the Tagliacozzian operation the parts must be kept in contact and immobilized by efficient apparatus.

11. Antiseptic dressings are applied in the case of external wounds, but should not be frequently changed. In operations involving mucous cavities, *e.g.*, the mouth or vagina, antiseptic lotions must be constantly used to keep the parts clean, but they should be well diluted and not forcibly injected.

CHAPTER XL.

AMPUTATIONS.

By the term **Amputation** is meant the removal of some portion of the body, which is injured or diseased to such a degree as to endanger the patient's life, or to preclude any hopes of its restoration to a normal, or even useful, condition. In this chapter we shall merely deal with the operation as applied to the extremities, amputations of organs such as the breast and penis having been described elsewhere. Necessary limitations of space force us to treat the subject somewhat briefly.

Methods of Amputation.—Since the introduction of anæsthesia, the methods employed for the purpose of removing limbs have been almost revolutionized; there is now no necessity to hurry through the operation, and hence many new proceedings, and these sometimes of a most complicated nature, have been devised. They are in the main merely modifications of three cardinal operations, the circular, the racquet-shaped, and the flap.

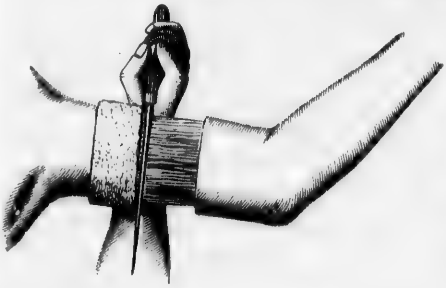


FIG. 373.—CIRCULAR AMPUTATION FOR UPPER ARM, SHOWING FLAP OF SKIN TURNED BACK, AND KNIFE APPLIED AS FOR DIVISION OF THE MUSCLES.

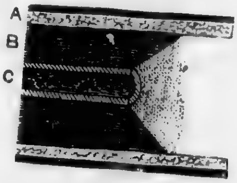
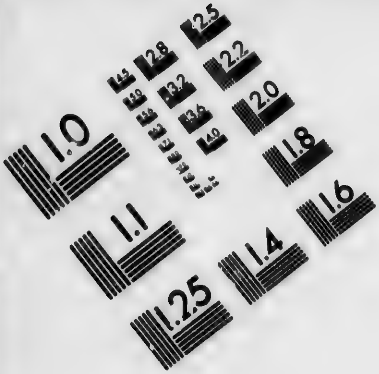


FIG. 374.—SECTION OF PARTS AFTER CIRCULAR AMPUTATION.

A, Skin and subcutaneous fat; B, muscles; C, bone.

The **Circular Amputation** (Fig. 373), although formerly much employed, is now but little used; in it the skin and subcutaneous tissues are divided around the whole circumference of the limb by a circular sweep of the knife. These are then retracted or dissected back like a cuff, and the superficial muscles divided in a similar manner. The soft parts are again further retracted, and the deeper muscles divided, allowing the bone to be cleared and sawn through at a still higher level. The end of the bone is thus placed at the apex of a conical hollow (Fig. 374), and can be completely covered over; the vessels,



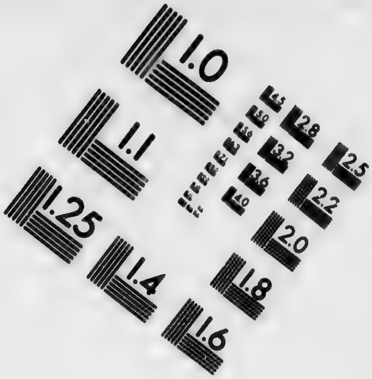
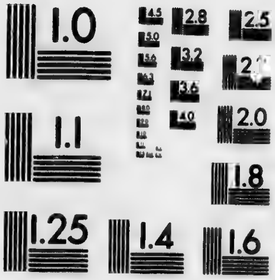
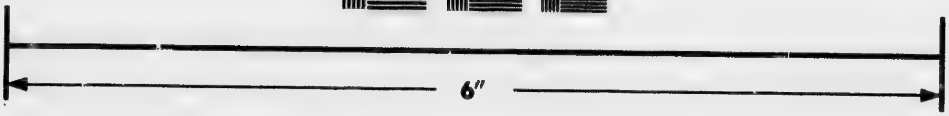
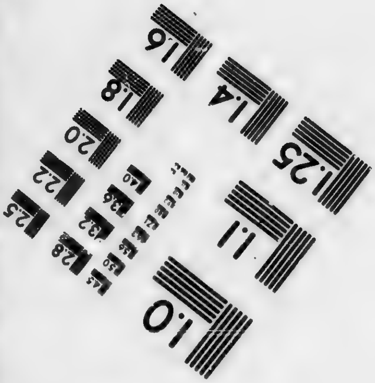
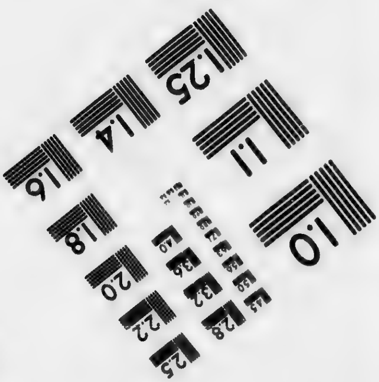


IMAGE EVALUATION TEST TARGET (MT-3)









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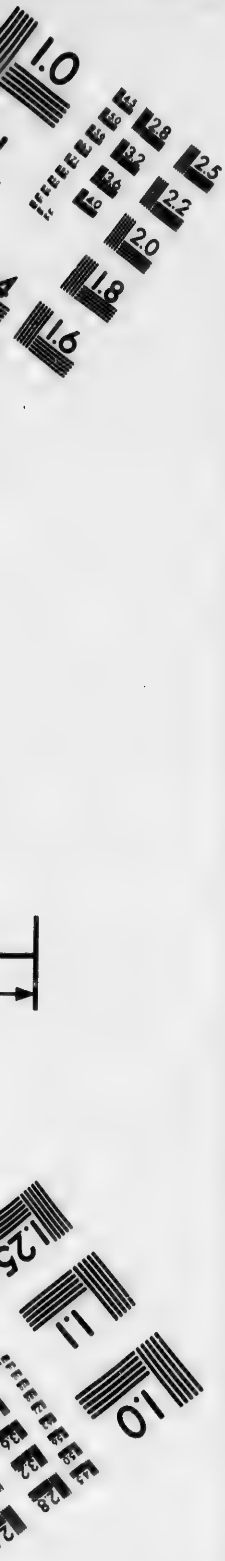
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moreover, are divided transversely. The stump is not very shapely, and after a time, owing to the shrinking of the soft parts, the cicatrix is likely to become attached to the bone. The upper arm is about the only situation in which a pure circular operation is ever undertaken at the present day; but a modified form is still occasionally utilized elsewhere. Thus, one or two vertical incisions may be associated with the circular cut, in order to facilitate the removal of the bone at a higher level, as in disarticulation of the hip-joint by Furneaux Jordan's method (p. 1137).

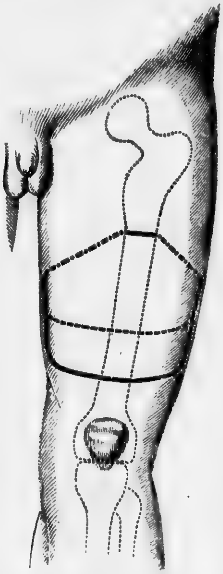

FIG. 375.—LISTER'S MODIFIED FLAP AND CIRCULAR AMPUTATION.

The continuous dark line indicates the outline of the anterior flap; the dotted line, the lower end of the posterior flap; the line of section and retraction of the muscles is represented as an interrupted line.

The **Racquet-shaped Method** (Fig. 379) is very similar to the last-described modification of the circular. In it an oval incision is made around the limb with one end pointed, and if necessary prolonged upwards to form, as it were, the handle of the racquet. This method is useful for removing fingers and toes, and is also employed at the hip and shoulder joints.

A somewhat similar operation is known as the **Elliptical** or **Oval Method** (Fig. 380, A). In it an oval incision is made around the limb; the lower or distal portion is then dissected up so as to enable the amputation or disarticulation to be completed at a spot a little below the proximal end. The free convex border of the flap is then turned over, and fitted into the concavity of the wound.

The **Flap Method** is that chiefly made use of at the present day in amputating through the shafts of the long bones. It was formerly performed by *transfixion* in order to save time; but the bulk of muscles included in the flap, and the fact that the vessels and nerves are often split longitudinally, render this an undesirable proceeding. Hence it has been discarded, and the flaps are now usually marked out superficially, and then raised by dissection. As a rule, they consist merely of skin and subcutaneous tissue, a little muscle being perhaps included towards the base.

The best method of amputating in muscular parts is that known as the **Modified Flap and Circular** (Fig. 375), which was originally suggested by Lord Lister. In this two rectangular flaps with the corners rounded off are raised on opposite sides of the limb, the length of the anterior being two-thirds of the diameter of the limb at the point at which it is proposed to divide the bone, and the posterior flap half the length of the anterior. These, consisting merely of skin and subcutaneous tissues, are dissected up; the muscles are then divided circularly, being retracted for another half-diameter. The advantages of the flap and circular methods are thus combined. In cutting the flaps it is most essential that they should not taper, but should remain the same breadth throughout, the corners being merely rounded off.

General Remarks on Amputations.

Certain important details must always be attended to by the operator when selecting an amputation suitable for any particular case.

1. A **Sufficient Covering** is necessarily required to order to protect the end of the bone from injurious pressure. If the skin were not contractile, and if the muscles had no tendency to retract, it would suffice to provide two flaps, each equal to half the diameter of the limb at the point of section of the bone; but owing to the contractility and retraction of living tissues, it is always necessary to provide at least a diameter and a half, and sometimes even two diameters; in non-muscular parts the former may be allowed, but in fleshy parts, especially when amputating low down in the thigh, where the range of muscular contraction is much greater, the latter. It is usually a matter of little significance whence the flaps are derived if other conditions are favourable; thus, a *single* flap, *e.g.*, a long anterior or posterior, is sometimes employed, but owing to the difficulty of maintaining its nutrition, is not to be recommended. *Equal* flaps are also used in parts like the arm, where the end of the stump will not be exposed to pressure. Generally, however, the *anterior flap* is cut *longer than the posterior*, as in the case of the modified flap and circular, or sometimes *vice versâ*; in the former, owing to the additional retraction of the muscles, a covering equal to two diameters of the limb is provided. *Teale's amputation* (Fig. 376) consists in raising a long rectangular anterior flap, equal in breadth and length to half the circumference of the limb at the point of section of the bone, and including everything down to the bone. The posterior flap is similar in nature to the anterior, but only a quarter of its length. The free end of the anterior flap is doubled over, and accurately stitched to the posterior. The advantages claimed for this operation are that the vessels are cut long, and thus the nutrition of the flaps secured, whilst a covering nearly equal to two diameters of the limb is provided. The great objection to the method consists in the amount of the limb which has to be sacrificed on account of the length of the anterior flap, and hence it is rarely employed. Occasionally the covering is derived from the sides of the limb (amputation by *lateral flaps*).

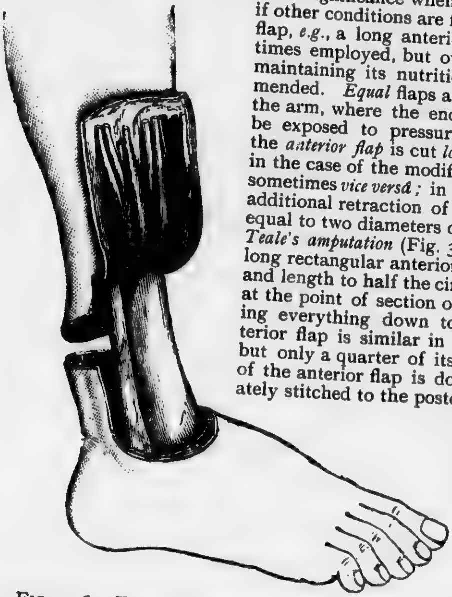

FIG. 376.—TEALE'S AMPUTATION. (TREVES' 'OPERATIVE SURGERY.')

2. The **Cicatrix** should be situated away from the end of the bone, especially in the lower extremity, where the weight of the body has to rest upon the stump.

3. A **Dependent Opening** is desirable for purposes of drainage, and to ensure this the anterior flap is often made longer than the posterior. This, however, is not such an important matter since the introduction of antiseptic methods.

4. All these objects should be attained with as **little sacrifice of the limbs a possible**, since the higher the operation, the greater the shock to the patient.

As to the operation itself, the greatest care must be taken to maintain **Asepsis**, since muscular and fascial planes have been freely opened, and possibly the medullary cavity of the bone exposed; the dangers of septic absorption under such circumstances is obvious. **Hæmorrhage** is prevented by previously exsanguinating the limb by elevating it for two or three minutes, and then applying an elastic tourniquet. In the leg a piece of rubber tubing may be employed, Samway's tourniquet being perhaps the best. In the arm, however, the subcutaneous position of the principal nerves leaves them much exposed, and paralytic symptoms have followed the use of such appliances, especially when made of solid rubber; a flat elastic bandage carried several times around the limb, and secured by tying or with a safety-pin, is all that is needed. Should the tourniquet have to be applied close to the area of operation, it must, of course, be soaked in carbolic or sublimate lotion; it is then advisable to protect the skin over which it is placed by a few layers of gauze, so as to prevent blistering. After the limb has been removed, the main vessels are at once ligatured, both artery and vein being separately tied. It is well to isolate and draw them down for a little distance, so as to make sure that they have not been buttonholed. Any other vessels which can be seen are tied before the tourniquet is removed. An assistant should for a time be ready to control the main trunk after releasing it from the tourniquet. In some cases it may be impracticable or undesirable to apply a tourniquet, and then the main vessels may be temporarily controlled by digital compression at some suitable spot whilst the amputation is completed. Any bleeding-points are rapidly secured by pressure forceps, and subsequently tied, and the main trunks isolated, and clamped or ligatured before division.

For special methods of controlling the hæmorrhage in amputation through the hip-joint, see p. 1136.

We have already drawn attention to the necessity of not tapering the flaps, but of cutting them square, the corners alone being rounded. In dissecting them up, the deep fascia should be included with the flap, and the blade of the knife always turned towards the part which is to be removed, so that the under surface of the flap, and with it the nutrient vessels, shall not be scored. Whilst dividing the muscles, the flaps must be carefully guarded by the hands of assistants. Before sawing the bone, it is recommended that the periosteum should be retracted for some distance, so as to more efficiently provide for its nutrition; this plan should certainly be adopted for the humerus and femur. Any irregular bony spicules left after sawing should be trimmed off with cutting pliers. Attention must next be directed to the main nerves, and to any tendons which lie exposed in the wound, all such structures being divided, the nerves as high as possible. The wound is usually closed by a continuous suture, but one or two deep tension stitches should also be inserted, and provision made for drainage from one of the angles of the incision. The dressing is applied in such a way as to draw the flaps down over the end of the bone, and a splint is often necessary in order to control the upper ends of the divided muscles, and to keep them at rest.

The chief **Complications** likely to arise in the subsequent course of the case are shock, reactionary hæmorrhage, and those which result from sepsis; all these conditions, and the treatment suitable to them, have been described elsewhere.

In a **Healthy Stump**, the end of the bone is rounded, and the medullary cavity closed by a layer of compact tissue. The divided muscles and tendons are either incorporated in the cicatrix, or gain fresh adhesions to the bones. The vessels are obliterated as far as the next patent branches, whilst the nerve-ends usually become bulbous, but, if suitably shortened, do not adhere either to the end of the bone or to the cicatrix, and hence give rise to no trouble. A sufficient covering of non-adherent skin and subcutaneous tissue should form a pad for the protection of the bones.

Affections of Stumps.—(*a*) *Necrosis* of the end of the bone is sometimes the result of carelessness on the part of assistants, who can readily denude it of its periosteum by rough sponging, etc.; it rarely follows if the periosteum has been first retracted before the bone is divided, and practically never apart from sepsis. A small annular sequestrum is usually all that separates, but should the inflammation spread up the medullary cavity (*septic osteomyelitis*), a more extensive destruction of bone tissue follows (for symptoms and treatment of which see p. 529). (*b*) *Sloughing of the ends of the flaps* occurs in debilitated individuals, especially if thin skin flaps have been employed, or if their nutrition has been impaired by trauma, or if unhealthy tissue has been incorporated in their substance by amputating too close to the seat of disease or injury. The process is usually limited in extent, and rarely calls for treatment other than keeping the part dry and aseptic, the slough being then slowly absorbed; if sepsis is present, the consequences may be very serious, even necessitating re-amputation at a higher level. (*c*) A *conical stump* results either from the flaps being cut too short, or from the parts shrinking as a result of septic inflammation, or in young people from continued growth of the upper epiphyseal cartilage of the divided bone. In bad cases the bone may even project through the integument, and necrose; re-amputation is the only treatment. (*d*) A *painful stump* is usually due to the adhesion of a bulbous nerve-end to the cicatrix or bone, so that it is dragged upon at each movement of the limb. The pain is of a severe neuralgic nature, and is treated by excising the bulb, or re-amputation.

Special Amputations.

Amputation of the Fingers is frequently required after machine accidents and such-like injuries, or in necrosis following a whitlow; in these cases it is often impossible to follow any regular routine, the flaps being obtained from any portion of sound tissue present. The following, however, are the chief plans adopted:

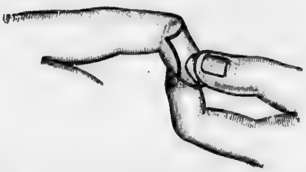

FIG. 377.—INCISIONS FOR AMPUTATION OF TERMINAL PHALANX OF FINGER. (TILLMANNS.)

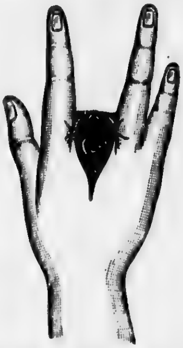

FIG. 378.—AMPUTATION OF FINGER AT METACARPO-PHALANGEAL ARTICULATION, SHOWING DIVIDED TENDONS AND LIGATURED VESSELS. (TILLMANNS.)

Amputation of the Terminal Phalanx is usually conducted by opening the joint on the dorsal aspect, and cutting a palmar flap from the pulp of the finger (Fig. 377).

No useful result follows amputation through the first inter-phalangeal articulation, since the portion left is practically fixed and useless, no tendons being inserted to govern it. An operation which is sometimes advantageous consists in amputating through the middle of the second phalanx, so as to leave the insertion of the flexor sublimis tendon, the flaps for such an operation being derived from any part of the finger, and the bone divided by cutting pliers.

Removal of a finger **at the Metacarpo-phalangeal Joint** is an operation frequently necessary (Fig. 378). It is best conducted by means of a racquet-shaped incision (Fig. 379, A), which starts over the knuckle, extends well forwards towards the centre of the web between it and the next finger, curves round to the palmar aspect so as to be placed a little below the crease in the skin at the root of the finger (Fig. 380, C), and returns in the same way to the back of the knuckle. This incision can be made with one sweep of the knife, but there is no real advantage in such a procedure. The articulation is then opened from behind, and is found further forward than one would at first expect; the structures on either side are then successively divided, making them tense by rotation of the finger, and the flexor tendons finally cut across. Bleeding-points (usually one on each side) are secured, and the wound closed. It may be advisable to insert a small strip of gauze as a drain for a day or two.

The question of removing the head of the metacarpal bone is one which must be decided by the occupation of the patient; if he is a working man, or needs strength of hand, it should be left, as its removal always causes weakness. In ladies and those where smallness and elegance of the hand are required rather than strength, it can be taken away by slightly prolonging the incision upwards, clearing the bone on either side, and applying cutting pliers. The gap between the adjoining fingers can in this way be almost obliterated. It is especially advisable to do this in the case of the index-finger, since the head of the second metacarpal bone forms an unsightly projection, and is very exposed to injury. For this finger, Farabœuf's method (Fig. 379, B) is often used (p. 1130).

When a portion of the metacarpal bone has to be removed for disease as well as the finger, the same proceeding should be adopted. Occasionally the four fingers and their attached metacarpal bones have to be removed *en bloc*. Short equal flaps may then be cut from the front and back of the hand, and the disarticulation effected. The stump that remains, although consisting merely of the carpus and thumb, is very serviceable.

Amputation of the Thumb should never be undertaken unless absolutely necessary, since its removal seriously impairs the functional utility of the hand. Any stump, however small, must be saved, if practicable, so as to assist the patient in grasping. The phalanges may be removed by any method which enables the bone to be covered with the least possible sacrifice.

When it is necessary to take away in addition the metacarpal bone, one of the two following methods should be employed:

1. *The racquet method* (Fig. 379, C). In this an incision commences in the intertendinous hollow known as the *tabatière*, and extends along the dorsum of the thumb to the head of the metacarpal bone, the oval portion sweeping round it at the level of the web when the thumb is abducted, and on the palmar aspect corresponding to the oblique crease at its root. The remainder of the operation resembles that for removal of a finger. Care must be taken not to wound the trunk of the radial artery as it passes through the base of the interosseous space; the blade of the knife is therefore kept closely applied to the bone.

2. By a *palmar flap*. In this the knife is first carried across the dorsal aspect of the thumb, from the centre of the web between it and the index-finger, to a point on the palmar aspect of the wrist just above the thenar eminence. The knife is then rotated so that its cutting-edge looks outwards, and inserted deeply through the ball of the thumb, transfixing it, so as to emerge at the same spot in the centre of the web as that at which the incision commenced. A muscular flap with a well-rounded border is readily fashioned by cutting outwards. The remaining soft parts are then divided, and disarticulation completed by opening the joint. It is a prettier and more showy operation than the former, but otherwise has no advantages.

Amputation at the Wrist-Joint is seldom performed except for injuries, and then the flaps must be derived as best they can from healthy tissues. Three chief methods are, however, described: (*a*) In the *elliptical* (Fig. 380, A), the incision takes the form of an ellipse, the highest point being on the dorsum

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½ inch below the level of the wrist-joint, and the lowest in the centre of the palm 2 inches below the former. On the ulnar side, the incision passes between the pisiform bone and the base of the fifth metacarpal, whilst on the radial side it crosses the carpo-metacarpal articulation. After dividing the cellular tissue, and dissecting up the palmar flap, the joint is opened from the posterior aspect, and the disarticulation completed. The convex end of the palmar flap is fitted into the concavity of the dorsum, and the cicatrix thus forms a curved line on the back of the stump. (*b*) A *long palmar flap* (Fig. 380, B) is sometimes utilized, extending from just below either styloid process down to about the middle of the metacarpal bones, the sides of this flap being parallel to each other. The dorsal incision crosses the carpus horizontally between the two extremities of the former wound. The palmar flap is then dissected up so as to include only skin and subcutaneous tissue, with perhaps a little muscular tissue from the thenar and hypothenar eminences. The wrist-joint is opened from the dorsum, and the amputation completed by the division of the flexor tendons. (*c*) In a few cases, amputation by an *external flap* (Fig. 381) may be desirable (Dubreuil's method). The incision commences at the junction of the middle and outer thirds of the back of the wrist, reaches down to the head of the metacarpal bone of the thumb, terminating at a point in the palm immediately opposite its commencement. This flap is dissected up, and should contain a certain amount of muscular substance from the thenar eminence. The skin and subcutaneous tissues on the ulnar aspect are now divided by a circular sweep of the knife around the inner side of the limb. Disarticulation follows, and the external flap is carried inwards, and sutured so as to close the wound.

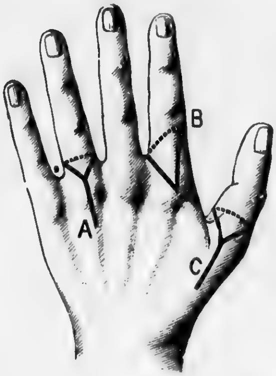

Fig. 379.—A, Incision for amputation of finger by racquet method; B, Farabœuf's method of amputating, as applied for index-finger; C, racquet-shaped incision for disarticulation of thumb at carpo-metacarpal joint.

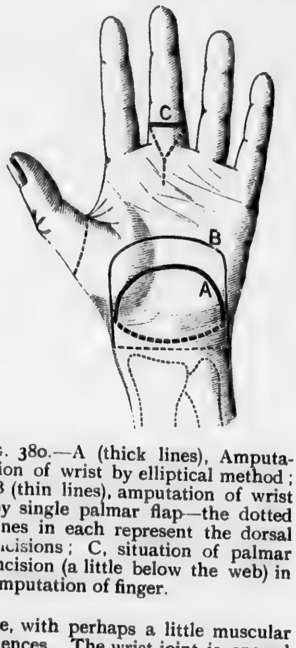

Fig. 380.—A (thick lines), Amputation of wrist by elliptical method; B (thin lines), amputation of wrist by single palmar flap—the dotted lines in each represent the dorsal incisions; C, situation of palmar incision (a little below the web) in amputation of finger.

Amputation through the Forearm is usually conducted by means of a flap operation, the flaps being either equal in length or one a little longer than the other. The muscles are divided circularly, and the bones should be thoroughly cleared before dividing them.

Disarticulation at the Elbow-Joint is an operation very rarely seen, and is either undertaken by the elliptical method or with a large anterior flap.

Amputation of the Arm may be carried out by any of the methods described, *e.g.*, the flap, circular, or modified flap and circular, the choice in any particular instance being determined by the requirements of the case. The circular amputation gives perhaps as good results as any.

Disarticulation at the Shoulder-Joint.—Three chief methods are practised for the performance of this operation, viz., Spence's and Larrey's, or that by means of an external or deltoid flap. In all, the third part of the subclavian artery is best controlled by digital compression, the surgeon endeavouring to leave the division of the main vessels until the last stage of the proceedings.

(*a*) *Spence's operation* (Fig. 382).—A preliminary incision similar to that for excision of the shoulder is first made, extending downwards and outwards through the fibres of the deltoid, from a point midway between the coracoid and acromion processes. This passes directly down the bone, and, if necessary, the joint is at once opened and examined prior to any further steps being taken. The surgeon, standing on the outer side of the limb, then carries his knife from the lower part of the incision downwards and inwards across the axillary folds around the limb to the point from which it first started, thus making the incision racquet-shaped. The soft structures on the outer side of the vertical incision are separated from the bone, and then the outer half of the capsule, the muscles inserted into the greater tuberosity of the humerus, and the long tendon of the biceps, are divided. The parts on the inner side of the joint, including the subscapularis and front of the capsule, are dealt with in a similar way, but the main vessels and nerves are left intact for a time. By retracting the external flap and protruding the head of the bone from its socket, the remainder of the capsule can be severed, and then the knife, travelling downwards between the humerus and the axillary vessels, is made to cut its way out, thus completing the disarticulation, the vessels being divided as the last step in the proceeding. If the knife is kept close to the bone, the trunk of the posterior circumflex artery is not interfered with.

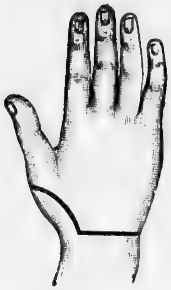

FIG. 381.—AMPUTATION OF WRIST BY DUBREUIL'S METHOD. (TILLMANNS.)

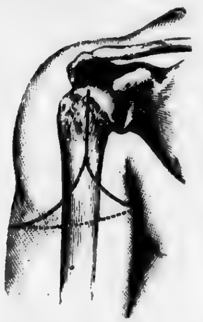

FIG. 382.—SPENCE'S AMPUTATION AT THE SHOULDER BY ANTERIOR RACQUET. (TREVES' 'OPERATIVE SURGERY.')

(*b*) *Larrey's operation* (Fig. 383) is very similar to the above, except that the vertical incision is made on the outer aspect of the joint, reaching downwards from the prominence of the acromion for a distance of about 6 inches, the oval portion starting from its centre, and being directed obliquely downwards and inwards. The tissues are reflected on either side from the humerus; the joint is opened by a transverse cut over the great tuberosity, which also divides the muscles inserted into it. The knife is finally carried down on the inner side of the humerus so as to sever the vessels last.

(*c*) Amputation by the external or *deltoid* flap is but little practised at the present time. The flap may be either cut by transfixion, or may be dissected up. It is U-shaped, its base extending from the coracoid process in front to the root of the acromion behind. A skin incision is now made across the inner aspect of the limb, joining the ends of the former incision, and extending about 2 inches below the axilla. Disarticulation is then carried out in the same way as in the previous methods.

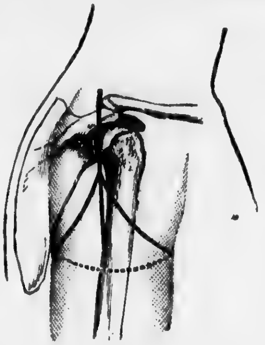

FIG. 383.—LARREY'S AMPUTATION THROUGH THE SHOULDER JOINT BY EXTERNAL RACQUET. (TREVES' 'OPERATIVE SURGERY.')

Occasionally it is necessary to remove the whole of the upper limb, together with the scapula and outer third of the clavicle, for new growths, usually of a sarcomatous nature, or for injury. This so-called **Interscapulo-thoracic Amputation** is best performed according to Berger's method. An incision is made along the middle third of the clavicle, and this portion of bone is then removed so as to enable the surgeon to divide between ligatures the subclavian artery and vein on a level with the lower border of the first rib. The anterior flap is then formed by an incision reaching from the centre of the former, and extending downwards and outwards over the shoulder, across the anterior fold of the axilla, and as far as the lower angle of the scapula. The pectorales major and minor are divided along this line, thereby exposing the brachial plexus, the constituent nerves of which are severed on a level with the section of the vessels. The axillary space can now be opened up along the outer surface of the serratus magnus. The limb is then rotated inwards and adducted across the trunk, and the patient drawn well to the edge of the table so as to enable posterior incision, which unites the outer ends of the two former, to be made. The flap thus marked out is dissected up, and the different muscles retaining the scapula in connection with the body are divided one after the other, including the trapezius, omo-hyoid, levator anguli scapulæ, rhomboids, and serratus magnus. These may be incised as near to the bone as is thought compatible with the total removal of the growth. Any remaining fibres are cut across, and the limb is thus detached. In cases of new growth there may be a large number of vessels, both arteries and veins requiring ligature; but in a healthy limb removed for injury, none but the posterior scapular and suprascapular will give any trouble. Naturally, such an operation is accompanied with a considerable amount of shock, but the results hitherto obtained have been encouraging.

Amputations of the Lower Extremity.

Amputation of the Toes at the metatarso-phalangeal articulations is precisely similar to the analogous operation on the fingers. It must be remembered that the joint lies as far behind the web as the apex of the toe is in front of it, and hence the incision must start farther back than might be expected.

For the removal of the great toe from the metatarsal bone, *Farabœuf's opera-*

tion is the best. The incision (Fig. 384) commences over the head of the latter bone, and well to the inner side of the extensor tendon; it extends downwards nearly as far as the interphalangeal articulation, and then crosses the plantar surface of the toe so as to reach the centre of the web between it and the second toe; thence the knife is carried straight back to the commencement of the incision. These cuts are deepened, the tendons divided, the joint opened, and the toe removed. It will then be found that an internal flap remains, which can be brought across the head of the metatarsal bone, and covers it in so that the cicatrix is not exposed to pressure.

Amputation of the great toe at the tarso-metatarsal articulation is conducted either by a racquet-shaped incision, or by dissecting up a flap from the inner side.

Amputation of a foot at the **Tarso-metatarsal Articulation** is performed either by Lisfranc's or Hey's operation.

Lisfranc's amputation (Fig. 385) consists really of a disarticulation, no bone being sawn across. The patient lies on the back with the foot elevated, and extending beyond the end of the table. A slightly convex dorsal incision extending down to the bones is made from the tip of the fifth metatarsal bone on the outer side to the base of the first on the inner. The plantar flap is then marked out reaching from the termination of the former incision forwards as far as the roots of the toes, and being necessarily longer on the inner than the outer side. The flap thus marked out is dissected up, the toes being fully extended by an assistant; only the skin and subcutaneous tissue are raised for the first inch, but further back all the structures in the sole of the foot are included. The appearance of the peroneus longus tendon will indicate that the dissection has been carried backwards far enough. Disarticulation is now performed from the dorsal aspect, the line of the joints (Fig. 386) being kept in

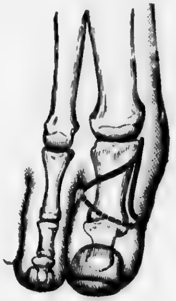

FIG. 384.—FARABŒUF'S AMPUTATION OF THE GREAT TOE. (TREVES' 'OPERATIVE SURGERY.')

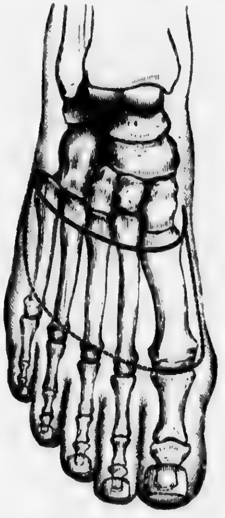

FIG. 385.—INCISIONS FOR LISFRANC'S AMPUTATION. (TREVES' 'OPERATIVE SURGERY.')

mind. The knife is entered behind the spur of the fifth metatarsal bone, and is at first directed forwards and inwards towards the head of the first metatarsal bone. The line of the articulation is then followed as far as the base of the second metatarsal, which projects backwards between the internal and external cuneiform bones. The joint between the first metatarsal, and the internal cuneiform is now opened transversely on the inner side, and the dorsal ligament between the second metatarsal and the middle cuneiform divided. The strong interosseous ligament passing between the internal cuneiform and the base of the second metatarsal is next severed by inserting the point of a knife downwards between the first and second metatarsal bones, and cutting backwards towards the ankle, elevating the handle of the knife in order to do so. By grasping the toes in the left hand, and forcibly extending them, the remaining ligaments on the dorsal aspect are divided, and the disarticulation can then be completed.

The plantar flap is sometimes formed as the last stage of the operation, having merely been mapped out in the first instance. In such a case the dorsal incision is first made, the metatarsus disarticulated, and the plantar flap cut from within outwards. After the plantar and metatarsal arteries have been secured by ligatures, the plantar flap is sutured to the incision on the dorsum.

Hey's operation is essentially similar to the above, with the exception that the base of the second metatarsal and, perhaps, the projection of the internal cuneiform are sawn across, leaving a more even surface of bone. It is certainly to be preferred to a simple disarticulation.

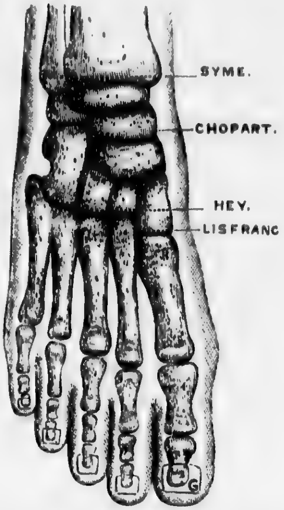

FIG. 386.—SKELETON AND OUTLINE OF FOOT, SHOWING LEVEL OF VARIOUS AMPUTATIONS.

Amputation at the Mid-tarsal Joint (*Chopart's amputation*, Fig. 387) is conducted in a very similar manner to Lisfranc's. A plantar flap with convex end is marked out, reaching on the inner side of the foot from a point immediately behind the tubercle of the scaphoid forwards to within 1 inch of the root of the toes, and terminating on the outer side on a level with the calcaneo-cuboid articulation, *i.e.*, midway between an external malleolus and the spur of the fifth metatarsal. It should be 1 inch longer on the inner than on the outer side. This plantar flap is first dissected up, including everything down to the bones, and then a dorsal incision is made with a slightly convex border. The joints between the astragalus and scaphoid on the inner side, and between the os calcis and cuboid on the outer, are opened from above, the foot during this proceeding being forcibly extended. Disarticulation is completed by a few touches of the knife, and after all hæmorrhage has been arrested, the plantar flap is drawn up, and united by sutures to the dorsal. Some surgeons prefer to fashion the plantar flap after opening the joints from the dorsum.

Chopart's amputation is, on the whole, not a very satisfactory proceeding, since it consists in the removal of the anterior segment of the arch of the foot, the posterior half being left without support. The natural result of this is that the head of the astragalus travels downwards, and presses upon the anterior portion of the stump, causing a good deal of pain and discomfort, whilst the os calcis is drawn upwards by the traction of the tendo Achillis. Formerly it was considered that the resulting deformity was mainly due to unbalanced muscular traction, and hence attempts to prevent it were made by dividing the tendo Achillis, or by stitching the extensor tendons to the under surface of the os calcis. Seeing, however, that the trouble is mainly mechanical, and hence unavoidable, it would perhaps be wiser to avoid the operation entirely, substituting for it a subastragaloid amputation, or modifying it by removing the astragalus after the foot has been taken away. Tripier's amputation has also been utilized to prevent such displacement; in it an oblique external racquet is made, reaching backwards to the anterior border of the tendo Achillis; disarticulation follows at the mid-tarsal joint, and then the os calcis is sawn across horizontally on a level with the sustentaculum tali, so as to leave a broad base of support, which is not so likely to become tilted forwards. It is but fair to say, however, that in not a few cases of Chopart's amputation an excellent stump remains without any of these inconveniences.

Subastragaloid Amputation of the foot is occasionally possible in cases of injury, where the astragalus remains uninjured. The best plan to adopt is that known as *Maurice Perrin's oval operation*. A racquet-shaped incision is made, commencing at the insertion of the tendo Achillis, and extending along the outer border of the foot to a point immediately behind the spur of the fifth metatarsal, from which it sweeps over the dorsum, along the instep, and after crossing the sole returns to the same spot. The dorsal part of the flap is then dissected up, the astragalo-scaphoid joint opened, the tendo Achillis divided, and by twisting the foot inwards the joints between the astragalus and os calcis can be entered, and the interosseous ligament severed. By still further inverting the foot until it assumes a position of extreme varus, the structures on the inner side of the os calcis can be detached, and by continuing the same torsion, the under surface of the bone is finally cleared, the dorsal aspect of the foot looking downwards. When the foot has been removed, bleeding-points are secured, tendons and nerves cut short, and the wound, which now lies horizontally, is secured by sutures. A very firm basis of support is provided by this operation, and the stump is covered by the skin of the heel, which is used to pressure.

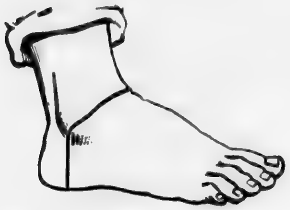

FIG. 387.—INCISIONS IN SYME'S AMPUTATION OF FOOT.

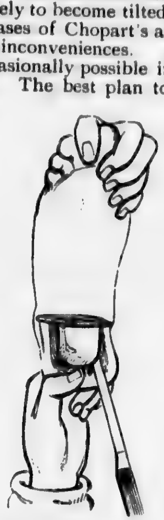

FIG. 388.—METHOD OF RAISING HEEL FLAP FROM OS CALCIS.

Amputation of the Foot.—*Syme's amputation* consists of a disarticulation at the ankle-joint, together with removal of the two malleoli and the articular surface of the tibia. The patient lies on the back with the leg well elevated and projecting over the end of the table, the surgeon standing either below or a little to the right of the patient. Having exsanguinated the limb, the operation is, on the left foot, commenced by making an incision from the tip of the external malleolus down to the heel, and extending up to a point ¾ inch below and behind the internal malleolus (Fig. 387). On the right side the incision is made in the opposite direction. For this purpose a short-handled strong-bladed knife should be employed (an ankle-knife). The incision is directed slightly backwards, otherwise a bucket-shaped heel flap is formed, in which discharges may collect. The knife is carried down to the bone at the first cut, and the surgeon then proceeds to dissect up the heel flap thus marked out by inserting his thumb into the wound, and partly peeling, partly cutting, the soft tissues at the back of the os calcis (Fig. 388). This is sometimes a tedious and tiring proceeding, since it is most important to keep close to the bone for fear of dividing the nutrient vessels of the flap (external and internal calcanean). The dorsal incision is then made, uniting the ends of the former wound, and carried slightly forwards so that a short convex flap is thereby formed. This is dissected up, and the ankle-joint opened, the line of the articulation being placed ½ inch above the tip of the internal malleolus. By division of the lateral and posterior ligaments, of the tendo Achillis, and of the few remaining fibrous connections along the top of the os calcis, the foot is removed. The lower ends of the tibia and fibula are then cleared and sawn off, the ends of the dorsal flap being meanwhile held out of harm's way (Fig. 389). The main vessels are tied, as also any other bleeding-points; the tendons and chief nerves are drawn down and cut short, and the wound closed by sutures, provision being made for drainage through one of the angles.

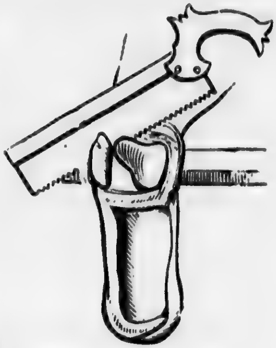

FIG. 389.—SECTION OF TIBIA AND FIBULA IN SYME'S AMPUTATION.

A much quicker and prettier method of performing this operation consists in opening the joint, and disarticulating immediately after the incisions have been made, whilst the os calcis is subsequently dissected out of the heel flap from above, keeping the knife close to the bone.

Syme's amputation gives excellent results with only slight shortening, and the patient is able to walk on skin which is already accustomed to pressure. It is especially useful where amputation is required for tarsal disease, inasmuch as it is then rarely safe to undertake any of the partial or more conservative methods of operating.

Pirogoff's operation is one in which the posterior portion of the os calcis is sawn off, and applied to the under surface of the previously-sawn ends of the tibia and fibula. The operation here described is not strictly that of Pirogoff, but rather the modification of it suggested by Sedillot. The patient and surgeon being relatively placed as for Syme's operation, an incision is made extending from the same points, viz., between the tip of the external malleolus and a point ¾ inch below and behind the inner malleolus, but instead of passing directly downwards is carried obliquely forwards. Everything is divided at once down to the bone, and the dorsal incision is then made, being placed at right angles to the plantar. The ankle-joint is opened from above, and disarticulation completed, the foot being extended, and the structures to the side of and behind the joint divided, so that a saw can be applied to the exposed surface of the os calcis, and the bone divided along the line of the plantar flap. The lower ends of the tibia and fibula are now cleared, and the malleolus and articular surface sawn off obliquely, the saw-cut being as nearly as possible parallel to that made through the os calcis. The object of this obliquity is to enable the sawn end of the posterior part of the os calcis to be brought into apposition with the similarly treated ends of the bones of the leg, and wired to them without any traction on the tendo Achillis. By this operation a somewhat longer stump is obtained than in Syme's, and the patient is able to walk on the posterior part of the os calcis instead of on the sawn ends of the tibia and fibula. The operation is principally applicable to cases of injury, rather than disease.

Amputations of the Leg may be undertaken either immediately above the malleoli (supramalleolar), or in the middle third, or a hand's-breadth below the knee (site of election). In the two former positions almost any operation may be practised according to the needs of the case, but perhaps the most satisfactory is the modified flap and circular already described at p. 1122. In dividing the bones, care must be taken not to leave a sharp projecting edge on the front of the tibia. This is best prevented by partially sawing through the bone in an oblique direction from above downwards, and when this has reached a little beyond it[illegible], the saw is withdrawn, and a horizontal incision made, cutting ac[illegible] oblique incision in such a way as to remove a wedge of bone from [illegible] the tibia, which thus becomes suitably bevelled (Fig. 390). The [illegible] uld always be divided before completing the section of the tibia.

In the lower third of the leg, Teale's amputation (Fig. 376) is sometimes recommended, and gives good results.

Amputation of the Leg at the Site of Election may be performed either by the modified flap and circular operation, or by a large external flap (*Farabœuf's operation*). In the latter, the external flap (Fig. 390, A C), which is U-shaped, is first marked out with the knife, extending 1½ inches higher in front than behind, and its length being equal to the diameter of the limb at the point at which the bones are to be divided. The incision on the inner side is then made, extending from a point 1½ inches below the upper end of the anterior horn of the former incision to the extremity of the posterior horn (Fig. 390, B C). The external flap is dissected up, commencing anteriorly, the fingers and knife being inserted between the tibialis anticus and the tibia; all the soft parts down to the bone and interosseous membrane are divided obliquely. The anterior tibial artery is cut long, and care must be taken not to free the flap from the interosseous membrane too high, for fear of injuring the trunk of this vessel as it passes between the bones, an accident which would seriously imperil the vitality of this large and fleshy mass. The tissues on the inner side of the limb are now divided, either by transfixion or circular division. The interosseous membrane and bones are bared, and the saw applied according to the method already described.

Amputation by *equal lateral* flaps is also recommended in this situation, but is not altogether satisfactory, owing to the fact of the cicatrix being placed over the end of the tibia, which is thus likely to project between the flaps.

Disarticulation at the Knee-Joint is a very useful and valuable proceeding. The methods chiefly employed are as follows: (i.) *Stephen Smith's operation*, or amputation by equal lateral flaps. The surgeon should stand on the same side of the patient as the limb to be removed. The incisions extend from a point immediately below the tuberosity of the tibia backwards in a semilunar fashion, to terminate in the middle line behind on a level with the joint (Fig. 391). The incision on the inner side should reach a little lower than that on the outer, in order to ensure sufficient covering for the inner condyle, which is always larger than the outer. The flaps are dissected up all round, including the subcutaneous and deep fascia, being turned back in front like a collar, so as to enable the surgeon to reach and divide the insertion of the ligamentum patellæ. The knife is now carried along the upper margin of the tibia, separating the attachments of the semilunar cartilages to the bones by dividing the coronary ligaments. The surrounding muscles and tendons are cut through at the same level, together with the crucial ligaments, and the leg is finally separated by boldly sweeping the knife through the soft parts at the back of the joint, the flaps being well retracted. The popliteal vessels are secured, and the flaps drawn together in the median line. When union has occurred, the cicatrix is drawn up behind into the intercondyloid notch, so that an excellent hooded covering is provided for the lower end of the femur. The chief objection to the operation is that the upper part of the synovial membrane of the joint remains intact, and may become distended by a serous effusion through the irritation produced by wearing an artificial limb. (ii.) Amputation can be undertaken by a *long anterior flap*, the patella being left *in situ* or removed, according to circumstances. A short posterior flap is also formed and dissected up, so as to enable the muscles and vessels to be divided transversely.

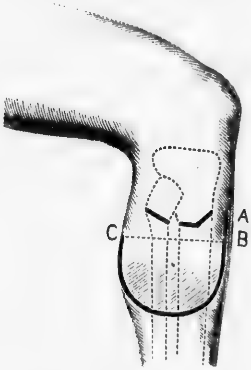

FIG. 390.—FARABŒUF'S AMPUTATION AT THE SITE OF ELECTION, A HAND'S BREADTH BELOW THE KNEE.

The continuous line, A, B, C, indicates the shape of the large external flap; the dotted line, B, C, the incision on the inner side of the limb. The direction in which the bones are sawn is also shown.

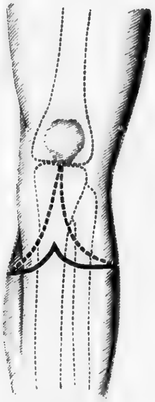

FIG. 391.—STEPHEN SMITH'S AMPUTATION THROUGH THE KNEE-JOINT BY LATERAL FLAPS.

Supracondyloid Amputation of the Thigh is an operation often requisite in order to deal with disease or injury involving the knee-joint. (*a*) *Carden's amputation* is one excellently adapted to this purpose. It consists in the formation of an anterior flap, extending from the level at which the femur is to be divided to a point midway between the lower border of the patella and the tubercle of the tibia; this is dissected up as far as the upper border of the patella. A short posterior flap is then cut by transfixion, and usually there is a good deal of retraction, since the hamstring muscles are included in it. The soft parts are now divided down to the bone all round just above the patella by cutting from without inwards, and retracted for a short distance. The condyles thus cleared are removed by the saw in a direction parallel to the articular surface. The chief objection to this operation is the length of the anterior flap, which is badly nourished, and sometimes liable to slough. (*b*) *Lister's modification* of this consists in making a transverse incision across the front of the limb on a level with the upper border of the tibia. The horns of this incision are joined posteriorly by carrying the knife downwards at an angle of forty-five degrees to the axis of the leg. This flap is dissected up, and the whole of the integuments and subcutaneous tissues are freed and retracted like a cuff, so as to enable the muscles to be divided circularly just above the patella. The saw is then applied, and the bone removed. By this means the covering of the end of the bone is taken more from the back than from the front of the limb. (*c*) *Gritti's operation* is thus performed: A large anterior flap similar to that used in Carden's operation is dissected up, including the patella, and a shorter posterior flap is then fashioned. The soft parts are divided by a circular cut of the knife, and the femur sawn across about the level of the adductor tubercle. The cartilaginous surface of the patella is then removed with the saw, and the remaining portion of the bone secured by a silver wire to the divided end of the femur. Considerable difficulty may be experienced in keeping the patella in accurate apposition, and to obviate this Stokes has recommended division of the femur at a slightly higher level (above rather than through the condyles). (*d*) Amputation by a *long posterior flap* is sometimes required in cases where the tissues in front of the limb have become disorganized from disease of the joint, or when cicatrices produced by a previous excision are present. The posterior flap is first marked out and dissected up, including merely the skin and subcutaneous tissues. A transverse incision is made across the limb above the cicatrices or sinuses, the bone sawn just above the site of the preceding excision, and the posterior muscles and vessels divided circularly. A very good stump usually results.

Amputation of the Thigh may be conducted by any of the general methods already described, but the modified flap and circular (Lister's operation, Fig. 375) is that generally employed.

Amputation through the Hip-Joint.—Disarticulation at the hip-joint is always an operation of the greatest gravity, and every precaution should be taken to minimize the immediate risks by preventing hæmorrhage and lessening shock. No part of the body is unnecessarily exposed, whilst the head is kept low, and although the operation should not be hurried over, no time must be wasted.

Perhaps the best way of preventing hæmorrhage is to secure the main vessels before dividing them, and then to take up each bleeding-point as it appears; the limb can thus be removed with merely the loss of a few ounces of blood. Other plans which have been suggested are: (*a*) Lister's aortic tourniquet, which, however, is not to be recommended, partly because it is difficult to apply to stout or muscular individuals, and in any case it is very liable to slip. (*b*) Davy's rectal lever for compression of the common iliac artery consists of a rod of ebony, vulcanite, or metal, which is inserted into the rectum, and directed so as to compress the artery against the brim of the pelvis. It is dangerous in application, and not always efficient. (*c*) An elastic tourniquet may be applied either around the upper part of the thigh to control the lower end of the external iliac, or around the body in such a way as to compress the abdominal aorta. For the latter purpose a pin-cushion or pad is placed on the abdomen over the aorta, and behind the back a board projecting a few inches on each side of the trunk, and with two notches cut at either end. The elastic rod is passed over the cushion, and around the notches at the end of the board in a figure-of-8 fashion, sufficient tension being employed to force the cushion down on the aorta, and thus control the circulation through it. This method, which was also suggested by Lord Lister, is certainly efficient, though somewhat cumbersome. (*d*) More recently Wyeth, of New York, has introduced a method of preventing hæmorrhage by applying a rubber tourniquet close to the pelvic brim, which is prevented from slipping by inserting long needles immediately below it. The limb is first exsanguinated by elevation, or possibly by the use of an Esmarch's bandage. Two long steel needles, 10 inches in length and $\frac{3}{16}$ inch in thickness, are then inserted, one on the outer side of the thigh and one on the inner. The former 'is introduced $\frac{1}{4}$ inch below the anterior superior spine of the ilium, and slightly to the inner side of this prominence, and is made to traverse superficially for about 3 inches the muscles and fascia on the outer side of the hip emerging on a level with the point of entrance. The point of the second needle is thrust through the skin and tendon of origin of the adductor longus muscle $\frac{1}{2}$ inch below the crutch, the point emerging 1 inch below the tuber ischii. The points should be shielded at once with cork to prevent injury to the hands of the operator. No vessels are endangered by these skewers. A mat or compress of sterile gauze 2 inches thick and 4 inches square is laid over the femoral artery and vein as they cross the brim of the pelvis; over this a piece of strong white rubber tubing, $\frac{1}{2}$ inch in diameter when unstretched, and long enough when in position to go five or six times round the thigh, is now wound very tightly around and above the fixation needles and tied.'* By this means the limb can be removed with practically no loss of blood.

Formerly but one operation was available for the removal of the limb at the hip-joint, viz., by transfixion, the flaps being cut antero-posteriorly. The great advantage of this method was the rapidity with which it was executed; it has, however, been replaced by other plans, one of which should always be adopted.

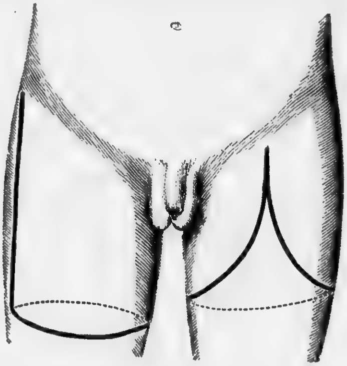

FIG. 392.—AMPUTATION THROUGH THE HIP-JOINT.

On the right leg Furneaux Jordan's method is indicated; on the left leg the flaps required for the anterior racquet operation are shown.

Amputation by an *external racquet incision* (Fig. 392) has been recommended by many surgeons, especially Furneaux Jordan, Esmarch, and Lister, each of whom has advocated some slight modification. The surgeon should always stand to the outer side of the limb, whilst the pelvis of the patient rests at the extreme edge of the table. The essential features of this operation consist in a circular division of the structures down to the bone below the lesser trochanter, whilst the head of the bone is disarticulated and removed through the external vertical portion of the incision extending downwards from above the great trochanter; it matters little whether the vertical incision is made before or after the tissues in the thigh have been divided. Perhaps the simplest plan of carrying out this operation is as follows: A circular incision is made through the skin and subcutaneous tissues 5 or 6 inches below the great trochanter. These are dissected up for a few inches, and the muscles then divided circularly down to the bone, which is at once sawn through. The external incision, 6 or 8 inches long, is then made, the tissues being freed from the anterior and posterior surfaces of the femur, and the rotator muscles divided along the borders of the great trochanter. The lower end of the fragment of the femur is then grasped by lion forceps, and after forcibly flexing and rotating the bone inwards, the capsule of the joint is laid open on its posterior aspect. By everting the bone, the anterior part of the capsule can be reached and incised, and the attachment of the ilio-psoas muscle severed. The ligamentum teres is then divided by inserting the point of the knife into the acetabulum, and the head of the bone is thus set free. One great advantage of this operation is that the incisions are placed as far as possible from the risk of septic contamination from the genital organs and perineum.

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* Wyeth, *Annals of Surgery*, February, 1897.

To our minds, the best method of amputating at the hip-joint is by means of an *anterior racquet incision* (Fig. 392). This commences over the centre of Poupart's ligament, and is carried down along the course of the main vessels for about 3 inches. It then sweeps over the inner side of the thigh 4 or 5 inches below the perineum to the back, and is brought up again to the front 3 or 4 inches below the great trochanter. The common femoral sheath is first exposed, and both artery and vein are secured by double ligature and divided. The muscular structures in the outer flap are then cut through, and the external circumflex artery and other bleeding vessels secured by pressure forceps *en route*. By rotating the limb inwards, the insertion of the gluteus maximus can be divided, as also the muscles attached to the great trochanter. The muscles in the inner flap are then similarly dealt with after rotating the limb outwards, the internal circumflex artery, etc., being secured. The capsular ligament is next divided transversely, and the head of the bone disarticulated. Finally, the limb is rotated forcibly outwards, and all the soft parts at the back of the limb, including the sciatic vessels and nerves, are divided from within outwards with one sweep of the knife. The wound when sutured lies antero-posteriorly.

CHAPTER XLI.

ANÆSTHESIA.

THE practice of surgery has always been of such a nature as to render some means of abolishing the pain caused thereby a desideratum; but although in the old days various plans were adopted to attain this object, yet it was not until the end of the last century that any real advance was made in this direction. In 1799 Sir Humphrey Davy suggested the possibility of using nitrous oxide gas as a means of rendering patients anæsthetic during surgical work; but although occasionally employed, it was so uncertain in its action that no great benefit was derived from the knowledge thus acquired, and it was not for many years that it came into extensive use. The demonstration of the properties possessed by ether in 1846 by Morton in Philadelphia, and by chloroform, in January, 1847, by Sir James (then Professor) Simpson, heralded in a new era of surgery. Operations, which before were scanty in number, became greatly multiplied, and at the present day, with our advanced knowledge and experience, and our constant dependence on this agent, it is difficult to understand how surgical practice could have been conducted without it. Its employment has enabled the surgeon to confidently attack almost every region of the body, and instead of operations being hurried over as formerly, in order to minimize the patient's sufferings, they are now undertaken with much more deliberation, accuracy being the great requisite at the present day, and not, as formerly, rapidity.

Anæsthetics may be divided into two groups—the local and the general.

Local Anæsthesia is utilized for the purpose of rendering parts insensitive to pain, where slight operations which will not last for long are to be undertaken, or occasionally in more serious cases where the patient cannot stand a general anæsthetic.

1. **Cocaine** is an alkaloid obtained from the dried leaves of the *Erythroxylon coca* (S. America). The salt most commonly used is the hydrochlorate, which exists in the form of colourless needles, or a crystalline powder readily soluble in water. Its properties as a local anæsthetic were discovered by Köller of Vienna, and it was at the Ophthalmic Congress at Heidelberg in September, 1884, that its value in ophthalmic and surgical work was first publicly demonstrated.

Mucous membranes are readily anæsthetized by applying a 5 per cent. or 10 per cent. solution to them for about five or ten minutes, the insensibility lasting for about the same time. In dealing with the skin or deeper tissues, hypodermic injections of the drug are relied on, the anæsthesia follows the course of the peripheral nerves. The action of cocaine is supposed to depend partly on an anæmic condition of the affected tissues induced by arterial contraction, partly on paralysis of the terminations of the sensory nerves. Much less effect is produced on inflamed tissues. In making use of this reagent, must always be remembered that cocaine has a distinctly depressing influence upon the heart, and hence more than ½ grain should never be employed.

The needle of the syringe should be inserted in the line of the incision, and the injection equally diffused along it. Should any toxic effects be manifested (as by pallor of the face, a cold clammy sweat, giddiness, weak and rapid pulse), the patient should be laid with the head low, and stimulants administered. Some recommend that a little nitro-glycerine (1 drop of a 1 per cent. solution) should always be injected at the same time as the cocaine, so as to prevent contraction of the peripheral arterioles. In some parts of the body it may be possible to control the circulation so as to hinder the general absorption of the drug. Thus, for circumcision the base of the penis may be constricted by an elastic band, whilst a similar arrangement may be applied to the fingers and toes for small operations, such as avulsion of a toe-nail.

2. A substitute for cocaine has recently been proposed in the synthetic compound known as **Eucaine Hydrochloride**. It is quite free from toxic properties, and doses of even 5 or 10 grains may be employed either hypodermically or by painting over a mucous membrane. Its action is somewhat slower than that of cocaine, and it causes a little congestion of the part, whilst cocaine leads to anæmia; it also gives rise to a little tingling pain on injection, and may leave a certain amount of œdematous thickening for a time. The reports hitherto given have been very satisfactory,

3. Local anæsthesia is also produced by **freezing** the part, either by the application of ice and salt, or by the ether spray, or with ethyl chloride. The latter reagent is now put up conveniently in small glass or thin metal flasks with a fine capillary outlet; on holding the flask in the hand a spray is produced, which is allowed to play upon the part to be operated on. The rapid evaporation from the surface leads to the freezing of the skin, which becomes of a dead white colour. The anæsthesia produced is of a very fugitive nature, and a certain amount of pain may be associated with the thawing process, but less than that caused by the ether spray.

4. The application of **Carbolic Lotion** (1 in 20) for a few minutes sometimes suffices to render the skin sufficiently insensitive to allow hypodermic injections and small incisions to be made without pain.

General Anæsthesia.—1. **Nitrous Oxide Gas** (N_2O) is most commonly used in dental work, or for short operations, such as bending a stiff joint and breaking down adhesions, the avulsion of a toe-nail, or the opening of an abscess. It is practically safe and not unpleasant, either in its use or in its subsequent effects. It is also employed in conjunction with ether, the patient being first anæsthetized with gas, and the condition maintained by ether. Gas has also been recommended for the removal of adenoids; but the general opinion now obtaining is that, to perform this operation satisfactorily, a more lasting anæsthetic is required. The gas is stored in a condensed and liquefied form in special steel cylinders, closed by a screw which can be readily loosened, so as to allow the gas to escape through a tube into an indiarubber bag. This is attached to a closely-fitting face-piece, with a suitable arrangement of valves and stop-cocks, by means of which the gas is allowed to reach the patient. A valvular exit for the expired air is also present. In its administration the bag is first filled with gas, and then air is completely excluded by carefully adjusting the padded face-piece to the irregularities of the face. Some anæsthetists, however, allow the administration of a minute proportion of pure oxygen at the same time, in order to prevent the lividity of the face and the twitching of the limbs often present when anæsthesia is induced in the ordinary way. The time taken in producing unconsciousness is usually about a minute and a half, and the patient is then ready for the operation, the anæsthesia lasting for about half a minute. In regions other than the face, a slightly longer period can be obtained by beginning the operation before the patient is fully anæsthetized, whilst by admitting a little air and then continuing with the gas, even three or four minutes can be obtained. Of course, in removing teeth the mouth is firmly gagged open prior to the commencement of the administration.

2. **Chloroform** is the anæsthetic perhaps most generally employed, on account

of the ease with which it can be administered, although there can be little doubt that its use is attended with somewhat more risk than that of ether. Much controversy has arisen as to whether the heart is ever directly affected by the drug, or whether the dangerous symptoms met with are not due to primary failure of the respiration. The experimental evidence on the subject is of a very conflicting nature, and it is impossible as yet to consider the question solved. The Scotch school of surgeons, headed by Syme and Lister, has always maintained that the breathing alone need be watched during the administration of chloroform, failure of the respiration being the first danger signal; the second so-called Hyderabad Commission has sought to confirm this view. Many practical surgeons and anæsthetists oppose this statement, holding that, although the respirations may fail first in a large percentage, and probably a majority, of fatal cases, yet there are a certain number in which heart failure is also seen as a result of the direct toxic effect of the chloroform upon its muscular substance. Certainly in not a few instances of death during the administration of chloroform the heart stops first, but a great distinction must be drawn between the *deaths* which result *from chloroform*, and the *deaths* that occur *during* the administration of *chloroform*. An overdose of chloroform, without doubt, leads to failure of the respirations; but in the majority of such cases, if suitable precautions are adopted sufficiently early, a fatal result may be averted. Cases in which the heart stops first are probably due to syncope, and are not entirely dependent on the nature of the anæsthetic administered.

Chloroform may be given in several different ways, but in all the chief points to be attended to are regularity of dose, and full admixture with air, so that not more than 4 per cent. of the vapour is inspired. The **Open Method** is that recommended by Lord Lister. A mask reaching from the root of the nose to the chin is made from the side of a towel, and fixed with a safety-pin. This is first held some inches above the patient's nose, and moistened from the outside with chloroform from a drop-bottle. As the respiratory passages become tolerant of the drug, the mask is gradually lowered to touch the face, and is kept continually moistened. At the end of two or three minutes the respirations increase in frequency, and a stage of excitement may be reached, during which the patient may sing, shout, or struggle violently. The anæsthetic is still cautiously pushed, care being taken that during the deep respirations which follow the struggling stage an overdose is not administered. Complete anæsthesia is indicated by relaxation of the muscles, loss of the corneal reflex, and contraction of the pupil, and it is usually attained under five minutes. As long as the operation lasts, the anæsthetist must endeavour to maintain this condition, but the amount needed during the later stages is much less than at its commencement.

Junker's inhaler is often used for giving chloroform, especially in operations about the nose and face. It is economical, and on the whole satisfactory. In this apparatus air is pumped through a layer of chloroform to an inhaler placed over the patient's mouth, or to a tube passed into his nose. The air laden with chloroform is inspired, and produces the usual constitutional effects; the amount administered is, to a certain extent, regulated by the rapidity with which the indiarubber bulb of the apparatus is squeezed; after a time, however, the lowered temperature induced by the evaporation leads to a diminution in the amount of chloroform vapour given off. Accidents have happened with this apparatus from filling the bottle too full, or from having the indiarubber tubes fixed to the wrong nozzles; in either instance liquid chloroform may be pumped out of the exit-tube.

3. **Ether** is generally considered to be a safer anæsthetic than chloroform, in that it is a cardiac stimulant. It is usually administered by Clover's apparatus or by an Ormsby's mask.

Clover's apparatus consists of a face-piece similar to that utilized for giving nitrous oxide, a metal receptacle for the ether, and a bag. As a rule, the patient is first anæsthetized with gas, and as soon as he is under its influence, the face-piece is disconnected, and to it is fitted the special Clover apparatus.

In this the air used in respiration passes over the surface of the ether contained in the receptacle, and by a clever arrangement of valves, etc., the proportion of ether inspired is regulated, so that at first a considerable admixture of air is permitted, whilst later on ether vapour in the proportion of a third, a half, or even two-thirds, is inhaled. The great value of this apparatus is the ease with which the amount of ether administered is regulated; but a distinct disadvantage exists in the fact that the patient breathes his own expired air again and again, and so, unless care is taken, he is likely to become somewhat cyanosed. This can, however, be prevented by removing the mask occasionally, and giving the patient a few breaths of unmixed air. Another objection lies in the amount of mucus which often collects about the pharynx, whilst the moisture in the expired air condenses in the bag, which becomes very objectionable unless carefully washed out.

In *Ormsby's mask* the ether is poured over a sponge which is contained in a wire frame prolonged from the face-piece, and covered over by a bag into which the patient breathes. It is an unpleasant means of inducing anæsthesia, but may be employed for maintaining it after the use of gas. The same objections hold good as in Clover's apparatus, and the same precautions as to letting in atmospheric air from time to time must be observed.

4. To obviate the depressing effects of chloroform, a combination known as the **A.C.E. Mixture** is often used, consisting of alcohol, chloroform, and ether, blended in the proportion of one, two, and three parts respectively. It may be given either from a Rendel's mask, or by the open method as for chloroform, but the latter plan is only applicable to children and weakly individuals, who require but little anæsthetic. *Rendel's mask* consists of a leather cone, the open end surrounded with a distensible rubber air-collar, and the fundus perforated with holes to permit of the free entrance of air. Two or three sponges are placed within it, and soaked with the anæsthetic, the patient breathing in and out of the cone. The inspired air is thus laden with the vapour, and the amount admitted is regulated in measure by covering a certain proportion of the inlet holes with the hand. The objection to this reagent is that it is not quite so powerful or certain as ether or chloroform, and that it evaporates somewhat unequally, the ether coming off first, and leaving an excess of chloroform, which when administered in a cone may be dangerous; such can, however, be obviated by remoistening the sponges alternately with the mixture and with pure ether.

General Remarks as to the Administration of Anæsthetics.

The medical practitioner must never lose sight of the fact that a certain element of risk must always be attached to the artificial induction of a condition in which the activity of the nervous system is entirely suspended, except for the maintenance of those phenomena which are actually necessary for life. Hence, an anæsthetic should never be given, unless absolutely necessary, without careful preparation of the patient, or such examination as shall satisfy the doctor as to his capability of safely taking it.

The **Preparation of the Patient** is a most important essential. Where practicable, the general habits of the individual should be carefully regulated for a few days prior to the operation, and on the preceding night the bowels are freely opened with a suitable purgative, castor-oil being perhaps the most efficacious. Any food given on the morning of the operation should be light and easily assimilable, whilst nothing should be taken for at least three hours previously, so as to make sure that the stomach is empty. In casualty cases, it may be advisable to relieve gastric distension with an emetic, or by washing out the organ before commencing the administration. The anæsthetist must ascertain that no loose artificial teeth are present in the mouth, and that no tight clothes or bands encircle the neck or thorax. In very nervous cases, or where much shock is anticipated, a preliminary hypodermic of strychnine or a nutrient enema may be administered.

The anæsthetic should never be pushed in the early stages, but is given slowly and gradually, especially in nervous individuals. When there is any struggling, the movements of the limbs should be restrained with as little force as possible, and care must be taken during the deep respirations which follow such struggling not to administer an overdose. The condition which the administrator should aim at maintaining is one characterized by total muscular relaxation, insensitiveness of the cornea, and a contracted state of the pupil, whilst the pulse and breathing continue regular. If the pupil tends to dilate, and the corneal reflex is present, the patient usually moves when the knife is used, indicating that more anæsthetic is required. Dilatation of the pupil with an insensitive cornea is always an indication for suspending the administration for a time. If the patient tends to come out of his unconscious state, vomiting is likely to follow, being ushered in by weakness and rapidity of the pulse, and pallor of the face; such may usually be averted by pushing the anæsthetic. The anæsthetist's chief attention must be directed to observing the state of the respiration and pupil; but he should also note the colour of the lips, cheeks, and ears, as thereby valuable information is gained as to the condition of the circulation. The pulse should be felt occasionally, but it is less important to attend to this than to the other points noted above. After the deep anæsthesia required in division of the skin, most operative proceedings on the subcutaneous tissues are comparatively painless, and hence the anæsthetic need not be pushed quite so far. Whilst the wound is being closed, the patient must be again somewhat more completely under control. In operations upon the mouth associated with hæmorrhage, the head must be occasionally turned to one side to allow the blood to gravitate out of the mouth, and the pharynx well sponged, so as to prevent the admission of clot and other matters into the air-passages. It is also a valuable routine plan to insist upon the head always being turned on one side, especially when ether is being given, since mucus tends to collect about the pharynx.

The **After-Treatment** of the patient is always a matter of considerable importance. He is placed on his back in bed with the head low, and when ether has been given, it is well to keep the head on one side. Where there is any tendency to shock, hot-water bottles, well wrapped up, should be applied to the feet and sides, and hot blankets over all. Absolute quiet must be enjoined for some hours, and the room darkened, so that, if possible, the patient may fall asleep. No food is administered for at least three or four hours, and then only very cautiously, a little weak tea, soda-water, or beef-tea being given. The patient is likely to vomit on returning from unconsciousness, perhaps bringing up a little bile-stained mucus, but if the anæsthetic has been judiciously given, it soon ceases. Occasionally, however, the vomiting persists for some time, becoming very troublesome. It may generally be checked by a hypodermic injection of morphia, and by washing out the mouth with warm water; but in more severe cases, lasting for some days, the patient's nutrition is maintained by enemata, and the stomach kept absolutely at rest. Benefit may sometimes be derived by giving a little bismuth and hydrocyanic acid in an effervescing mixture, or perhaps champagne; but, as a rule, all administration of food by the mouth should be stopped until the vomiting has ceased.

Three chief **Dangers** are encountered during the administration of anæsthetics:

1. **Obstructed Respiration** usually results from falling backwards of the root of the tongue, which blocks the entrance of air into the larynx. The respirations gradually become more and more stertorous, the face and ears become dusky, and, if the condition is not relieved, the chest continues to heave without any air entering or leaving it, and finally ceases when the patient is practically asphyxiated. The early stages of this condition are of common occurrence, whatever the anæsthetic, and the administrator must always be on the look-out and endeavour to prevent it by turning the head so that the tongue falls to one side. If it occurs in spite of this position being adopted, the administration is at once suspended, whilst the tongue must at all hazards be drawn forwards. This may be accomplished in the early stages by pulling on the beard or chin, or by pressing the mandible forwards by the fingers placed behind

the angle of the jaw. In the later stages the mouth should be forcibly opened by a gag, and the tongue grasped by forceps and pulled well forwards, or a finger may be passed back into the pharynx to draw the root and epiglottis forwards, and at the same time ascertain that the entrance to the glottis is free from obstruction. Artificial respiration should be undertaken if the breathing has actually stopped. Death should never result from this cause, and if it occurs, it can only be attributed to the carelessness of the anæsthetist.

Obstruction to the respiration may occasionally arise from the entrance of vomited material into the air-passages or lungs, the patient becoming cyanosed during an attack of vomiting, and passing rapidly into a state of asphyxia. In such a case the finger must be swept around the pharynx, if the mouth can be opened, to see that the glottis is clear, whilst tracheotomy or laryngotomy may be necessary should the teeth be firmly clenched, or if the obstruction is below the entrance to the glottis. Fortunately, this accident is of rare occurrence.

2. **Complete Cessation of Respiration** is the usual primary phenomenon from an overdose of chloroform; it is also stated to occur occasionally during ether narcosis. The pulse continues to beat distinctly for a few seconds, although respiratory movements have ceased. Treatment consists in at once stopping the administration, whilst the tongue is drawn forwards, and the fauces cleared by the finger. The head should be lowered over the end of the table, and young children may even be completely inverted, so as to induce a flow of blood to the head. Artificial respiration is commenced without delay, whilst the thoracic parietes may be flicked with a cold wet towel, or alternately douched with hot and cold water. Strychnine or ether should also be injected hypodermically, and if the condition persists, and the heart's action ceases, a Faradic current may be passed from the second or third intercostal space in front to an electrode placed over the spine. Attempts at resuscitation should be continued for a half to three-quarters of an hour. At the same time, these measures must be undertaken with discretion, as otherwise it is quite possible to extinguish the feeble spark of life by the very means which, used wisely, would have restored it.

3. Death occasionally results from primary **Cardiac Failure**, which may arise (*a*) from fright during the administration of the anæsthetic; (*b*) from shock with cardiac inhibition, by commencing the operation before complete anæsthesia has been obtained; and (*c*) from an overdose of chloroform or ether acting directly on the nerve centres or on the muscular substance of the heart. On post-mortem examination in such cases, the heart muscle is found to be thin and flabby, and perhaps infiltrated with fat; the ventricular walls are especially affected. Unfortunately, this condition cannot be recognised with certainty by the stethoscope. Patients with simple valvular lesions, where the defect has been more or less compensated, do not generally run any extra risk. The treatment to be adopted in cases of cardiac failure during anæsthesia is the same as for stoppage of the respiration.

The **Choice of an Anæsthetic** in any particular case depends mainly on the condition of the circulatory and respiratory apparatus of the patient. Ether is perhaps, on the whole, the safest drug to employ, especially in adults, although it is less pleasant to take; it may cause a good deal of bronchial irritation and congestion, and is more likely to give rise to troublesome after-vomiting, although such does not usually last for long. It is sometimes followed by unpleasant delirium. Chloroform is easier to administer, more pleasant to take, and less likely to lead to objectionable after-effects. It is the best anæsthetic for young children and old people, though its action upon the heart contra-indicates its use in patients whose circulation is weak. The A.C.E. mixture may also be safely employed, if the precautions already indicated at an earlier page are attended to.

Ether is certainly contra-indicated in patients suffering from any bronchitic or pulmonary trouble, and its administration for operations about the face or mouth is, of course, impracticable. Chloroform should not be given in cases of cardiac weakness or advanced renal disease; for abdominal work it is always to be preferred to any other agent, as also in operations on the brain.

INDEX

- **Abdominal** operations, general remarks on, 901
  - surgery (Chapter XXX.), 833-904
  - walls, injuries of, 833
- Abscess, acute, 34-43
  - alveolar, 665
  - anal, 961
  - axillary, 42
  - cerebellar, 746
  - cerebral, 487, 642, 746
  - chronic or tubercular, 43, 123, 251, 821, 828
    - diagnosis of, 251, 796, 825, 915
  - dorsal, 822, 828
  - iliac, 42, 826
  - in bone, 531, 535
  - in hip-joint disease, 594
  - intra-mammary, 42, 793, 796
  - ischio-rectal, 42, 823, 960
  - lacunar, 1096
  - lumbar, 822, 828
  - of labium, 1068
  - of liver, 891
  - of spleen, 900
  - of tongue, 702
  - palmar, 42, 190
  - perineal, 1060
  - perinephritic, 825, 986, 989
  - prostatic, 1039
  - psoas, 42, 822, 828
  - pyæmic, 108
  - residual, 45, 825
  - retro-pharyngeal, 42, 731, 822
  - subcranial, 470, 483, 488, 743
  - sublingual, 97, 710
  - submammary, 96, 793, 794, 796
  - subphrenic, 844, 855, 885
- A.C.E. mixture, 1142
- Acetabulum, fractures of, 403
- Acne, 681
- Acromegaly, 547, 614, 646
- Acromion, dislocation of, 439
  - fracture of, 387
- Actinomycosis, 21, 131, 883
- Acupressure, 219
- Acupuncture for aneurism, 259, 261, 267, 269
  - for abscess of liver, 892
- Adder's bite, 187
- Adductor longus, injury to, 347
- Adenoids, 694, 729
- Adenoma, 153
  - of adrenal bodies, 997
  - of breast, 799
  - of kidney, 996
  - of palatal glands, 724
  - of prostate, 1041
  - of rectum, 968
  - of testis, 166, 1079
  - of thyroid, 757
- Adeno-sarcoma of breast, 799, 801
- Adhesions in hernial sac, 907, 914, 927, 928, 936
  - in joints, 364, 558, 588
  - intraperitoneal, 839, 840, 846, 883, 943
- Adrenal tumours, 997
- Adventitious bursæ, 353
- Aërial fistula, 754
- Air into veins, entrance of. See Veins
- Air-passages, surgery of (Chapter XXVII.), 763-790
- Albuminuria, 1022
- Alopecia in syphilis, 1107
- Alveolar processes, affections of, 665-667
  - sarcoma, 141
- Amœba coli, 22, 891
- Ambulatory treatment of fractures, 371
- Amputations (Chapter XL.), 1121-1138
  - during shock, 182, 206
  - for acute arthritis, 566
  - for aneurism, 259, 267
  - for compound fractures, 375, 181, 365
  - for gangrene, 70, 72, 73, 75, 78, 181, 275, 365
  - for infantile paralysis, 832
  - for lacerated wounds, 180
  - for rupture of main artery, 182, 365
  - for sarcoma of bone, 553
  - for secondary hæmorrhage, 229
  - for spreading traumatic gangrene, 78
  - for tubercular diseases of joints, 574, 575, 576, 577, 597
- Amputation of penis, 1067
- Amussat's operation, 877

Amyloid degeneration, 46, 1023
Anæsthesia (Chapter XLI.), 1139-1144
  dolorosa, 824
Anæsthetic, choice of, 1144
  leprosy, 130
Anatomical wart, 124, 188
Anel's ligature for aneurism, 256
Aneurism (Chapter IX.), 246-271
  by anastomosis, 151, 554, 642
  cirsoid, 151, 642
  diffuse traumatic, 224, 236
  of bone (osteo-aneurism), 554
  varicose, 240, 642
Aneurismal varix, 238, 266, 297, 476, 642
Aneurisms, special, 260-271
Angina of Ludwig, 96, 710
Angioma, 151
Angular curvature of spine. See Pott's disease, 816
Ankle, acute arthritis of, 568
  amputation at, 577, 1133
  ankylosis of, 590
  effusion into, 558
  excision of, 605
  fracture dislocations of, 424, 456
  tubercular disease of, 577
Ankyloglossia, 700
Ankylosis, 71, 131, 324, 588, 595, 679, 830
Anthrax, 117
Antiseptic treatment of wounds, 199
Antistreptococcic serum, use of:
  before abdominal section, 901
    operations on tongue or pharynx, 710, 728, 730
    operations on joints, 456
  in cellulitis, 95
  in erysipelas, 103
  in pyæmia, 111
  in septicæmia, 106
Antrum, affections of, 668
Antyllus' ligature for aneurism, 256
Anus, affections of, 958, 961, 962, 964, 967, 968, 979
  artificial, 856, 859, 861, 863, 877, 932, 936, 939, 949, 955
Aorta, abdominal aneurism of, 268
    compression of, 225, 269, 1136
  ligature of, 270, 283
  thoracic aneurism of, 260
Aphasia, 493, 747
Apnœa, 788
Appendicitis, 881-890
Arachnoid cyst, 168, 174, 461, 476
Arm, amputation through, 1128
  deformities of, 616
Arterial hæmorrhage, 223
  thrombosis, 72, 74, 235, 246
Arteries, affections of (Chapter IX.), 235-271
  ligature of, 272-289
Arterio-venous wounds, 238
Arthrectomy for tubercular disease of joints, 573, 575, 576
Arthritis, acute, 428, 563, 678, 741
  deformans. See Osteo-arthritis
Arthrodesis, 832
Arthrotomy for acute arthritis, 566
  for tubercular disease, 573
Artificial respiration, 790
Ascarides, 960, 1015
Asepsis, 201
Asphyxia, 788
Aspiration for hydronephrosis, 993
  of bladder, 1059
  of chronic abscess, 48
  of empyema, 784
  of hepatic abscess and cyst, 892, 894
Astragalus, dislocation of, 457
  excision of, 605, 633
  tubercular disease of, 577
Atheroma, 241, 246
Atlas, dislocation of, 506, 824
Atony of bladder, 1017, 1031
Atrophic scirrhus, 162, 806
Atrophy of bone, 358, 405, 645
  of muscles, 320, 831
  of skull, 645
  of testis, 1088
Axillary abscess, 42, 310
  artery, aneurism of, 268
    ligature of, 280
  cellulitis, 96

Bacilli, 22
Bacillus anthracis, 22, 117
  coli communis, 36, 41, 89, 97, 525, 876, 833, 837, 856, 862, 891, 896, 930, 952, 960, 1007, 1050, 1094
  lepræ, 129
  of malignant œdema, 78, 94, 104
  mallei, 128
  tetani, 22, 111
  tuberculosis, 119, 120, 125, 312, 533, 569, 817, 987, 1011
  typhosus, 37, 525
Bacteria, 22-25
Baker's cysts, 167, 563
Balanitis, 1065, 1096
Ballooning of rectum, 966
Banks' (Mitchell) operation for hernia, 918
Barker's operation for fractured patella, 419
  operation for hernia, 920
Basal meningitis, 486
Base of skull, fracture of, 462
Basilar artery, aneurism of, 265
Bassini's operation for hernia, 921
Bedsores, 76, 505
Bell's palsy, 333
Bellocq's sound, 698
Berger's amputation of upper extremity, 1129
Biceps cruris, tenotomy of, 353
  humeri, injuries of, 344, 346
Bilharzia hæmatobia, 960, 985, 1021
Biliary fistula, 836, 896, 898
  passages, affections of, 895-899
Bites, snake, 187

Bladder, affections of (Chapter XXXV.), 1003-1038
Bladder in hernia, 908
Blood-clot, organization of, 196, 532
Blood-cysts, 170, 751
Boil, 82, 189, 740
Bone, diseases of (Chapter XVIII.), 517-555
Bougies, urethral, 1054
Brachial artery, compression of, 225
    ligature of, 281
  plexus, affections of, 336
    stretching of, 336
Brain. See under Cerebral, Concussion, and Compression
Branchial clefts, affections of, 748
Brasdor's operation for aneurism, 257, 264
Breast, diseases of (Chapter XXVIII.), 791-811
Bronchocele. See Goitre
Bronchus. See Air-passages
Bryant's test-line, 409
Bubo, 1096, 1099
Bubonocele, 909, 915
Bulb, hæmorrhage from artery of, 1035
Bullet wounds. See Gunshot wounds
Bunion, 638
Burns, 84
Bursæ, diseases of, 353
Bursal cysts in neck, 751

Cæcal hernia, 908
Cæcum, cancer of, 863
Calcium chloride in blood, 290
  sulphide in treatment of boils, 83
Calculus, biliary, 896, 945
  impacted in urethra, 1050
  intestinal, 946
  prostatic, 1040
  renal, 988
  salivary, 710, 712
  vesical, 1025
Callus, 366
Canalization of veins, 230
Cancellous osteoma, 146
Cancer, general facts of, 154-164
  of bladder, 1013
  of bone, 553
  of branchial cleft, 749
  of breast, 803
  of intestine, 862
  of jaw, 667, 671, 677
  of kidney, 997
  of lip, 663
  of œsophagus, 734
  of parotid, 713
  of penis, 1066
  of pharynx, 730
  of prostate, 1047
  of pylorus, 851
  of rectum, 968
  of scrotum (chimney-sweep's), 1092
  of testis, 1081
  of thyroid, 761
Cancer of tongue, 705
  of tonsil, 727
Cancrum oris, 79, 679, 700
Carboluria, 1023
Carbuncle, 80
Carcinoma. See Cancer
Carden's amputation, 1135
Caries, 520
  of spine, 816
  of temporal bone, 741
  syphilitic, 537
  tubercular, 534, 570
Carotid artery, aneurism of, 263
  compression of, 225, 263, 264, 756
  ligature of, 264, 265, 267, 275, 642
Carr's splint, 400
Cartilage, affections of, in joint disease, 560, 565, 570, 580, 584
  semilunar. See Semilunar
Cartilages, necrosis of laryngeal, 767-769
Cartilaginous tumours. See Chondroma
Caseation in tubercle, 122
Castration, 1090
  for enlarged prostate, 1046
Catgut ligatures, 221
Catheter fever, 1044
Catheterism, asepsis in, 505, 829, 1009, 1044, 1054
  dangers from, 1055
  difficulties in, 1055
  for enlarged prostate, 1044
Catheters, 1054
Cautery, uses of, 126, 219, 510, 572, 828, 971, 978
Cellulitis, 93-97
  of scalp, 96, 641
  pelvic, 97, 1006, 1014, 1035
  submaxillary, 96, 710
Cephalhæmatoma, 460
Cephalhydrocele, 461
Cephalotetanus, 114
Cerebellar abscess, 746
Cerebral abscess, 487, 642, 650, 746
  hæmorrhage, 477, 489
  irritation, 479
  tumours, 648
Cerumen in ear, 739
Cervical plexus, injury to, 336
  rib, 267, 609
Chancre, hard, 1102
  of anus, 966
  of lip, 661
  of nipple, 792
  of tongue, 704
  of tonsil, 727
  of urethra, 1051, 1103
Charcot's disease, 584
Chemiotaxis, 26
Chest. See Thorax
Chloroform, administration of, 1141
Cholecystectomy, 899
Cholecyst-enterostomy, 896, 899
Cholecystitis, 896
Cholecystotomy, 897, 898
Cholelithiasis, 896

Cholelithiasis, operations for, 898
Cholesterine, 44, 896
Chondroma, 145
Chopart's amputation, 1131
Chordee, 1097
Chylous hydrocele, 307, 1086
Chyluria, 1022
Cicatrices. See Scar
Circular amputation, 1121
Circumcision, 917, 1064
Circumflex nerve, affections of, 336
Cirsoid aneurism, 642
Clavicle, dislocations of, 437
    fractures of, 384
Claw hands in leprosy, 131
    of ulnar paralysis, 340
Claw foot, 637
Cleft palate, 717
Club foot, 627
    hand, 616
Coagulation necrosis, 13
Cocaine, 1139
Cocci. See Micrococci
Coccydynia, 405
Coccyx, excision of, 404, 959, 971, 972, 1091
    fracture of, 404
Cock's operation of perineal section, 1059
Coley's fluid, 143, 163
Colic, appendicular, 886
    biliary, 897
    renal, 990
Collapse, 202, 838, 932, 956
Colles's fracture, 398
    law, 1114
Colloid cancer, 163
Colotomy, 877, 951, 959, 967, 973, 981
    methods of, compared, 881
    uses of, 878
Columnar carcinoma, 160
        of bladder, 1013
        of breast, 807
        of intestine, 862
        of upper jaw, 671
        of rectum, 968
Coma, diabetic, 72, 1025
    diagnosis of, 482
    in cerebral abscess, 651
    in cerebral tumour, 649
    in head injuries, 480, 484, 485, 490, 497
    uræmic, 995, 1024
Compound fractures, 181, 373
Compression, cerebral, 480
Concussion, cerebral, 477
    of the spine, 508, 512
Condylomata, 153, 1106
    of anus, 967
Congenital cysts, 164
    dislocation, 429
    fracture, 359
    hernia, 911, 924, 926
    hydrocele, 1082
    malformations of rectum, 958
    syphilis, 1114
Congestive stricture, 1051
Conical stumps, 1125
Conjunctivitis, gonorrhœal, 1097
Contusions, 173, 179
    of abdominal walls, 833
    of intestines, 856
    of lung, 778
    of kidney, 983
    of nerves, 318
    of skull, 461
Costal cartilage, separation of, 384
Cowper's glands, inflammation of, 1097
Coxa vara, 620
Coxalgia and coxitis. See Hip disease, 591
Craniectomy, linear, 646
Craniotabes, 540, 541, 645
Cranium, injuries of, 461-473
    diseases of, 643-648
Crus cerebri, injuries to, 494
Crutch palsy, 337, 373
Cryptoscope, 184
Curvature of spine, angular, 816
        lateral, 609
Cut throat, 751
Cystine, 1026
Cystitis, 1007, 1031, 1036, 1043, 1097
    in spinal affections, 505, 511, 825
Cysto-adenoma, 153, 797, 799, 801, 808
Cystoscope, 1006, 1011, 1014
Cystotomy, perineal, 1006, 1010, 1015
    suprapubic, 1011, 1015, 1036
Cysts, 164-172
    blood, 170, 751
    branchial, 748
    dentigerous, 152, 675
    dermoid, 164, 643, 711, 749, 798, 815, 998
    hydatid, 170, 554, 649, 751, 786, 798, 893, 998
    implantation, 169
    in floor of mouth, 710
    involution, 795, 797
    Morrant Baker's, 167, 563
    mucous, 169
    of breast, 797
    of jaw, 152, 165, 675, 676
    of kidney, 998
    of labia, 1068
    of neck, 749
    of ovary, 166, 167
    of pancreas, 899
    of round ligament, 167
    of spermatic cord, 167
    of thyroid, 757
    of thyro-glossal duct, 165, 705, 711, 749
    of Wolffian body, 166
    sebaceous, 168
    serous, 168, 751, 798
Czerny-Lembert suture, 865

Dactylitis, tubercular, 533
Deformities (Chapter XX.), 606-640
    in rickets, 541

Degeneration, cysts of, 172
    in arteries, 244
    in nerves, 319
Delirium tremens, 208, 363
Dentigerous cysts, 152, 675
Depressed fractures, 467
Dermoid cysts. See Cysts
Diabetes, 1024
Diabetic gangrene, 71
Diaphragmatic hernia, 926
Diffuse traumatic aneurism, 224, 236
Digital compression of arteries, 225, 254
Dilatation of cardiac orifice, 733, 736, 847
    of œsophagus, 736
    of pylorus, 850
    of rectum, 966
    of urethra, 1056
Dislocations (Chapter XV.), 429-459
    of spine, 506
Dissecting aneurism, 243, 249
Dissection wounds, 188
Distal ligature for aneurism, 257, 263, 264, 267
Distension of bladder with overflow, 1016, 1018
Disunited fracture, 378
Diverticula of œsophagus, 732
Diverticulum of Meckel, 855, 944
Dorsalis pedis artery, ligature of, 289
Drainage in abdominal operations, 903
    treatment of wounds, 178
Drowning, 789
Dry gangrene, 64
Duct cancer, 797, 807
    papilloma, 797, 802
Duodenum, perforating ulcer of, 85, 855
Dupuytren's contraction, 618
    fracture, 425
    splint, 426, 427
Dura mater, injuries of, 470, 484
        sarcoma of, 647
    thickening of, causing epilepsy, 497
Dysphagia, 737
Dyspnœa. See Asphyxia

Ear, affections of (Chapter XXV.), 739-747
Ecchondroses, 146
Echinococcus, tænia, 170, 293, 893
Ecthyma, 1108
Ectopia vesicæ, 1003
Ectrodactylism, 617
Ectropion, 652
Eczema of external auditory meatus, 740
    of nipple (Paget's), 133, 792
    varicose, 56, 298
Eczematous ulcer, 55
Eggshell crackling, 551, 554, 648, 669, 676
Elbow-joint, acute arthritis of, 567
    amputation through, 1128
    ankylosis of, 589
    dislocations at, 443
    effusion into, 557
    excision of, 601
Elbow-joint, tubercular disease of, 575
Electrolysis for aneurism, 258, 261
    for cirsoid aneurism, 642
    for hydatid cysts, 894
    for intra-orbital aneurism, 266
    for nævi, 301, 663
Elephantiasis Arabum, 308
    Græcorum, 129
Emboli, 106, 243, 246, 247, 251, 292, 293, 363
Embolic gangrene, 68
Emphysema, surgical, 378, 648, 753, 779, 857
Empyema, 783, 826, 844, 892
    of antrum, 668
    of frontal sinuses, 648
Encephalitis, 485, 486
Encephalocele, 643
Encephaloid cancer, 162
Encysted hernia, 912
    hydrocele of cord, 167, 915, 1085
        of round ligament, 167
End-to-end anastomosis of gut, 868
Endarteritis, 31, 121, 241, 244, 1108, 1109
Endocarditis, infective, 107
Endosteal sarcoma, 550, 647, 676
Enterectomy, 835, 859, 862, 863, 866, 936, 937, 949, 955
Enteritis, acute, 938
Enterocele, 908
Enteroliths, 946
Enteroplasty, 862, 866
Enterorrhaphy, 867
Enterostomy, 866
Enterotome, Dupuytren's, 940
Enterotomy, 865, 948
Epididymitis, 1056, 1074, 1097
Epilepsy, traumatic, 497
Epiphysis, separation of, 360
Epiphysitis, 529, 535, 540
Epiplocele, 908
Epispadias, 1048
Epistaxis, 696
Epithelioma, 156
    after lupus, 125
    branchial, 749
    of anus, 968
    of bladder, 1013
    of glands in neck, 751, 754
    of gum, 667
    of jaw, lower, 677
        upper, 671
    of larynx, 769
    of lip, 663
    of nipple, 792
    of nose, 693
    of œsophagus, 734
    of palate, 724
    of penis, 1066
    of pharynx, 730
    of scalp, 643
    of scar, 198
    of tongue, 703, 705
    of tonsil, 727

Epulis, 145, 551, 666
Erethitic shock, 204
Ergot, gangrene from, 71
Erysipelas, 97, 641, 725, 729, 1091
  curative action of, 102, 143
Estlander's operation, 785
Ether, administration of, 1141
Ethmoid, diseases of the, 688
Eucaine, 1140
Excision of joints, 599-605
    for acute arthritis, 566, 678
    for ankylosis, 590
    for dislocations, 436
    for fractures, 364, 395
    for tubercular disease, 574
  of breast, 809
  of condyle of jaw, 679
  of Gasserian ganglion, 332
  of mandible, 677
  of maxilla, 672, 693, 694
  of parotid gland, 715
  of pylorus, 850, 852
  of rectum, 970
  of rib for empyema, 784
    for sub-phrenic abscess, 845, 893
  of thyroid, 758
  of varicocele, 1087
Exclusion of intestine, 863
Exomphalos, 924
Exophthalmic goitre, 760
Exophthalmos (proptosis), 265, 327, 465, 476, 668, 760
Exostoses, 146, 647
Exostosis bursata, 147
  of ear, 740
  of first rib, 267
  subungual, 147
Expansion of bone, 534, 550, 554
Extension of leg, 411
    in hip-joint disease, 596
External carotid, ligature of, 277, 715, 728, 730
External popliteal nerve, affections of, 342
Extracapsular fracture of femur, 406
    of humerus, 389
Extradural abscess. See Subcranial abscess
Extragenital chancres, 1103
Extra-medullary hæmorrhage, spinal, 509
Extravasation of urine, 1014, 1018, 1036, 1061
Extroversion of bladder. See Ectopia vesicæ, 1003
Exudation cysts, 167
Eyelids, affections of, 652

Facial artery, compression of, 225
    ligature of, 279
Facial cleft, oblique, 660
  paralysis, 333, 466, 714, 741
  nerve, affections of, 333
    operations on, 334
  tic, 334
Facies Hippocratica, 838, 932, 943
Fæcal fistula. See Fistula
Fæces, impaction of, 950
False joints, 375, 434
  passages, 1055
Farcy. See Glanders
Fat embolism, 363
Fatty hernia, 144, 926
  tumour. See Lipoma
Fauces, affections of, 728
Farabœuf's amputations, 1126, 1130, 1134
Femoral artery, aneurism of, 270, 271
    compression of, 226
    ligature of, 270, 271, 286, 309
  hernia, 922
    strangulated, 939
Femur, fractures of, 405
Fever, 17
Fibrin ferment, 18, 206, 218
Fibro-cystic disease of jaw, 676
    of testis, 1079
Fibroid, recurrent, 140, 803
Fibroma, 144, 149, 643, 666, 670, 692, 799, 831
Fibro-myoma, 144, 148, 172, 1041
Fibro-sarcoma, 140, 148
Fibrous union of fracture, 375
Fibula, fractures of, 422
Fifth nerve, affections of, 327
Fingers, amputations of, 1125
  chancre of, 1108
  deformities of, 616
Fissure of anus, 964, 976
  of lip, congenital, 653-660
Fissures of nipple, 791
Fistula, 49
  aerial, 754
  biliary, 836, 896, 898
  bimucosa, 860
  branchial, 748
  fæcal, 836, 840, 856, 860, 885, 889, 936, 940
  -in-ano, 962
  median cervical, 750
  œsophageal, 754
  penile, 1096
  perineal, 1039, 1046, 1053, 1063
  recto-vesical, 1014, 1035
  salivary, 716
  umbilical, 836
  urinary, 836, 1004, 1039, 1046, 1063, 1096
Flap amputation, 1122
Flat foot, 635
Floating kidney, 982
  spleen, 900
Foot, amputation of, 1132
  contusions of, 181
  deformities of, 627
Forcipressure, 219
Forearm, amputation through, 1128
Foreign bodies in air-passages, 685, 763
    in appendix, 882
    in bladder, 1006

- Foreign bodies in ear, 740
  - in hernial sac, 909
  - in intestine, 945
  - in nose, 685
  - in œsophagus, 732
  - in stomach, 843
  - in urethra, 1050
- Fourth nerve, paralysis of, 327
- Fractures (Chapter XIV.), 357-427
- Frank's operation of gastrostomy, 849
- Freezing for anæsthesia, 1140
- Frontal lobes, injuries of, 479, 493
  - sinuses, affections of, 648, 689
- Frost-bite, 83
- Furuncle. See Boil, 82, 740
- Fusiform aneurism, 248

- Galactocele, 797
- Gall-bladder, affections of, 895
- Gall-stones, 896, 945
- Ganglion, 350
- Gangrene (Chapter IV.), 63-88
  - after aneurism, 251, 253, 271
  - during treatment of fractures, 373
  - from ligature of main artery, 74, 274
  - from rupture of artery, 237
  - from splint pressure, 76, 373
  - of intestine, 930, 936, 949, 951
  - of lung, 786
  - senile, 72, 245, 246
- Gartner's duct, cyst of, 166
- Gasserian ganglion, removal of, 332
- Gastrectomy, 850
- Gastric ulcer, 843
- Gastrocnemius, rupture of, 347
- Gastro-enterostomy, 851, 853
- Gastrostomy, 737, 847
- Gastrotomy, 733, 846
- Genu recurvatum, 625
  - valgum, 543, 620
  - varum, 625
- Giant cells, 121, 125, 140, 216, 520
- Glanders, 128
- Glands, affections of lymphatic, 309-317
- Glass wounds, 183, 238
- Gleet, 1094
- Glenard's disease, 983
- Glioma, 139, 648
- Glossitis, 701
- Glosso-pharyngeal nerve, affections of, 335
- Gluteal artery, aneurism of, 270
  - hæmorrhage from, 233
  - ligature of, 285
- Goitre, 755
- Gonococcus, 37, 561, 564, 837, 1093
- Gonorrhœa, 1093
- Gout, 559, 579, 1019
- Granulation tissue, 198
- Granulomata, infective, 119
- Graves' disease, 760
- Gravel, 1018, 1027
- Gravitation paraplegia, 510
- Great sciatic nerve, affections of, 341
  - stretching of, 342
- Gritti's amputation, 1136
- Growth of bone, 518
- Gubernaculum testis, 1069
- Gumma, 1109
- Gums, affections of, 665
- Gun-shot wounds, 185
  - of abdomen, 859
  - of brain, 492
  - of lung, 781
  - of skull, 469

- Hæmatemesis, 211, 842
- Hæmatocele of cord, 915, 1072
  - of tunica vaginalis, 168, 1071
- Hæmatoma, 174
  - of abdominal walls, 833
  - of ear, 739
- Hæmaturia, 211, 1021, 1027
- Hæmoglobinuria, 71, 1022
- Hæmophilia, 233
  - joints in, 586
- Hæmoptysis, 211
- Hæmorrhage (Chapter VIII.), 210-234
  - during amputations, 1124
    - at hip-joint, 1136
  - from catheterism, 1055
  - in compound fractures, 373
  - special sources of, 232, 775
- Hæmorrhoids, 297, 973
- Hæmothorax, 779
- Hahn's tracheotomy-tube, 708, 774
- Hallux valgus, 637
- Halsted's operation for hernia, 921
  - suture, 865
- Hammer-toe, 639
- Hammond's splint for fracture of mandible, 381
- Hand, amputations of, 1125
  - deformities of, 616, 618
- Hare-lip, 653
- Head injuries (Chapter XVI.), 460-498
- Healing, 194
  - by granulation, 194
  - by organization of blood-clot, 196
  - under a scab, 196
- Heart, wounds of, 787
- Heat-stroke, 482
- Hectic fever, 45, 90, 565, 571, 596, 825
- Hernia (Chapter XXXI.), 905-941
  - cerebri, 470, 496
  - en bissac, 914, 934
  - fatty, 144, 915, 926
  - femoral, 922
  - inguinal, 909
  - interstitial, 914, 934
  - of lung, 782, 787
  - testis, 1074, 1078
  - ventral, 835, 926
- Herpes labialis, 662
  - in neuralgia, 325
  - preputialis, 1066
- Hey's amputation, 1130
  - saw, 472
- Hilton's method of opening abscess, 42
- Hip-joint, acute arthritis of, 526, 567

Hip-joint, amputation through, 597, 1136
  ankylosis, 590
  congenital dislocation of, 429
  dislocations of, 447
  effusion into, 557
  excision of, 597, 603
  osteo-arthritis of, 583
  tubercular disease of, 591
Hodgen's splint, 411
Hodgkin's disease, 316
Horn, sebaceous, 168, 1066
Hospital gangrene, 79
Housemaid's knee, 355
Howship's lacunæ, 520
Humerus, fractures of, 389
Hunterian chancre, 1102
  ligature for aneurism, 256
Hunter's canal, ligature of femoral artery in, 287
Hydatid cysts, 170
  of bone, 554
  of brain, 649
  of breast, 798
  of kidney, 998
  of liver, 891, 893
  of lung, 786
  of muscle, 348
  of spleen, 901
  of Morgagni, 166, 1085
Hydrarthrosis, 562
Hydrocele, chylous, 307
  of breast, 798
  of cord, 167, 1085
  of hernial sac, 907
  of neck, 751
  of round ligament, 167
  of tunica vaginalis, 167, 1081
Hydrocephalus, 645, 814
Hydronephrosis, 97, 989, 991, 1009, 1014, 1043
Hydrophobia, 115
Hydrops antri, 669
  articuli, 562
  of frontal sinuses, 648
Hygroma, 307, 749, 750, 816
Hyoid, fracture of, 382
Hyperostoses, 148
Hypertrophy of breast, 801
  of gums, 666
  of prostate, 1041
Hypopyon, 41
Hypoglossal, injury to, 335
Hypospadias, 1048
Hypostatic pneumonia, 373
Hysteria in spinal injuries, 512
Hysterical joints, 588, 625

Ileo-colostomy, 862, 863
Iliac abscess, 42, 44, 823
  aneurism, 269
  colotomy, 879
  vessels, ligature of, 270, 283, 284, 285
Immunity, 24
Impacted calculus in urethra, 1050
  fæces, 950
Impacted fracture, 359
  gall-stones, 897
Impassable stricture, treatment of, 1058
Imperforate anus, 959
Impermeable stricture of urethra, 1052
Implantation cysts, 169
Incised wounds, 175
Incontinence of urine, 824, 1015
Infantile hernia, 912
  hydrocele, 1082
  paralysis, 831
Infarct, hæmorrhagic, 108, 294; and see Emboli
Infection, 92
Inferior dental nerve, operations on, 331
Inflammation (Chapter I.), 1-33
Inflamed hernia, 927
Infra-orbital nerve, operations on, 330
Infusion of salt solution, 212
    for abdominal injuries, 834
    for hæmorrhage, 212
    for sepsis, 106
    for shock, 206
Inguinal aneurism, 269
  colotomy, 879
  hernia, 909, 923
    strangulated, 938
Inhalers, anæsthetic, 1140, 1141, 1142
Injections in gonorrhœa, 1095
  in treatment of nævi, 301
Innominate artery, aneurism of, 262
    ligature of, 267, 275
Intercostal artery, hæmorrhage from, 232, 781
Intermaxilla in hare-lip, 665
Intermediary hæmorrhage, 227
Internal iliac artery, ligature of, 284, 1046
  mammary artery, hæmorrhage, 232
    ligature of, 280
  popliteal nerve, affections of, 342
Interstitial hernia, 914
  keratitis, 1116
  mastitis, 794
Intestinal anastomosis, 863, 868, 874, 899
  obstruction (Chapter XXXII.), 942-957
Intestines, affections of, 855
  operations on, 863
Intracapsular fracture of humerus, 389
    of femur, 405
Intracranial aneurism, 265
  inflammation, 96, 483, 642
Intramammary abscess, 42, 794
Intramedullary hæmorrhage of spine, 509
Intrameningeal hæmorrhage, 476
Intra-orbital aneurism, 265
Intubation of larynx, 778
Intussusception, 946, 951, 953, 954
Inunction, mercurial, 1111
Inversion of testis, 1070
Involucrum, 523
Involution cysts, 795, 797
Iritis, syphilitic, 1107
Irreducible hernia, 927
Irritability of bladder, 1016

Irritable ulcer, 56
Ischio-rectal abscess, 42, 960
Ivory exostosis. See Osteoma

Jaundice, 890, 892, 895, 897
Jawbone. See Maxilla or Mandible
Jobert's operation, 868
Joints, diseases of (Chapter XIX.), 556-599
  injuries of (Chapter XV.), 428-459
Jugular vein, ligature of, 232, 746
Junker's inhaler, 1141

Keloid, 145, 198
Keratitis, interstitial, 1116
Kidney, affections of (Chapter XXXIV.), 982-1002
Kinking of gut, 841, 942, 946
  of ureter, 983, 992
Knee-joint, acute arthritis of, 568
  amputation through, 1134
  ankylosis of, 590, 625
  contractions of, 625
  dislocations of, 454
  effusion into, 557
  excision of, 604
  subluxation of, 455
  tubercular disease of, 576, 626
Knock-knee, 620
Kobelt's tubes, cysts in connection with, 166, 1085
Kocher's operation for hernia, 921
  on the tongue, 708
Kraske's operation, 959, 971
Kyphosis, 614

Labia, affections of, 1068
Lacerated wounds, 179
Laceration of brain, 488
Lacunar abscess, 1096
Laminectomy, 515
  in Pott's disease, 830
Laparotomy for abdominal contusion, 834
  for abdominal obstruction, 947, 950
  for cancer of intestine, 863
  for injury of intestine, 857
  for intussusception, 955
  for perforation of appendix, 887, 888
    of stomach, 845
  for peritonitic adhesions, 841
  for peritonitis, 839
    tubercular, 841
  for rupture of gall-bladder, 895
    of intestine, 858, 859
    of liver, 891
    of stomach, 842
  for ulcer of stomach, 843
Lardaceous disease, 46, 246, 1023
Larrey's operation, 11[illegible]
Laryngeal paralysis, 261, 264, 265, 735, 754
  stenosis, 754
Laryngectomy, 770
Laryngitis, œdematous, 97, 100, 382, 710, 731, 732, 752, 767
Laryngoscope, 766
Laryngotomy, 763, 764, 771
Larynx, diseases of, 766
  foreign bodies in, 763
  injuries of, 752, 765
Lateral anastomosis, 863, 874, 899
  curvature of spine. See Scoliosis, 609
  implantation, 863
  sinus, thrombosis of, 107, 744
Leg, amputation of, 1134
Leiomyoma, 148
Lembert's suture, 864
Leontiasis ossea, 646, 670
Leprosy, 129
Leucocytes, migration of, 11
  phagocytic action of, 25
Leucoplakia, 702
Ligature of vessels, 272
    causing gangrene, 74
    for hæmorrhage, 221
Lingual artery, ligature of, 277
  nerve, operations on, 331
Lip, affections of, 653-665
Lipoma, 143, 169, 816, 831, 915, 926
  arborescens, 144
  diffuse, 143
  nasi, 682
  of femoral canal, 923
  subserous, 144
Lisfranc's amputation, 1130
Lister's abdominal tourniquet, 269
  amputation, modified flap and circular, 1122
    supracondyloid, 1136
  antiseptic treatment of wounds, 199
    dressings, 201
Liston's long splint, 410
Lithiasis, 991, 1019
Litholapaxy, 1029
Lithotomy, lateral, 1031
  suprapubic, 1036
Lithotrity, 1029
Littré's hernia, 929, 943
  operation, 879
Liver, affections of, 890-895
Local anæsthesia, 1139
Localization of cerebral injuries, 493, 495
Loose bodies in joints, 586
Lordosis, 615
Loreta's operation, 736, 850
Lower jaw. See Mandible
Ludwig's angina, 96, 710
Lumbar abscess, 44, 822
  colotomy, 877, 878
  hernia, 926
  operations on kidney, 998, 999
Lungs, affections of, 778-787
Lupus, 123, 723
  action of erysipelas on, 102
  erythematosus, 126
  vulgaris, 124
Lymph varix, 306
Lymphadenitis, acute, 309

Lymphadenitis, chronic, 311
Lymphadenoma, 152, 314, 754
Lymphangiectasis, 306, 660
Lymphangitis, 90, 305
Lymphatic glands, affections of, 309-317
    vessels, affections of, 305-309
Lymphorrhœa, 307
Lympho-sarcoma, 139, 316, 754
    of testis, 1080
    of tonsil, 727

McBurney's spot, 884
MacEwen's operation for hernia, 920
        of osteotomy, 624
    treatment of aneurism, 259, 267, 269
Macrocheilia, 306, 660
Macrodactyly, 617
Macroglossia, 306, 701
Macrostoma, 660
Malar, fracture of, 379
Malarial spleen, 901
Malignancy, characteristics of, 134
Malignant endocarditis, 107
    œdema, 77
    pustule, 22, 61, 117, 118
    ulcer, 61
Mallet finger, 618
Malpositions of testis, 1069
Mamma. See Breast
Mandible, diseases of, 665
    excision of, 677
    injuries of, 379
    tumours of, 675
Mandibular cleft, 660
Massage in treatment of fractures, 372, 389, 394, 395, 401, 424, 427
Mastitis, acute, 792
    chronic, 794
Mastoid disease, 651, 741
Maunsell's operation, 855, 868, 955
Maxilla, affections of, 665
    injuries of, 379
Meckel's diverticulum, 855, 944
    ganglion, removal of, 330
Median hare-lip, 659
    nerve, affections of, 338
Medulla oblongata, injuries to, 494
    of bone, inflammation of. See Osteo-myelitis
Medullary cancer, 162
Melæna, 211
Melanotic sarcoma, 141, 667
Melon-seed bodies, 349, 355, 586
Meningeal hæmorrhage, cerebral, 232, 473, 474, 476
        spinal, 501, 509
Meningitis, 485, 651, 744
    spinal, 510
Meningocele, 643, 814
Meningo-myelocele, 812
Mercurialism, 665, 700, 1112
Metacarpals, dislocation of, 447
    fracture of, 402
Metastasis, 27, 711, 1073
Metatarsalgia, 640
Microcephaly, 645
Micrococci, 22
Microstoma, 660
Middle ear, affections of (Chapter XXV.), 739-747
    meningeal artery, hæmorrhage from, 232, 474
    turbinated bone, disease of, 688
Mirault's operation for hare-lip, 657
Moist gangrene, 64
Mollities ossium. See Osteo-malacia
Molluscum contagiosum, 22
    fibrosum, 145, 150
Morgagni, hydatid of, cysts from, 166, 1085
Morton's disease, 640
Motor area, topography of, 495
        wounds of, 493
Mouth, affections of, 699
Moveable kidney, 932
Mucous cysts, 169, 648, 662, 710
    membranes, tubercular disease of, 128
    polypus, 689
    tubercles, 153, 967, 1105, 1113
Mulberry calculus, 1025
Mumps, 711, 1073
Murphy's button, 846, 853, 871, 872, 876, [899
Muscles, affections of, 344-348
Musculo-spiral nerve, affections of, 337
Myelitis, spinal, 511
Myelocele, 812
Myeloid sarcoma, 140, 551, 667
Myoma, 148
Myo-sarcoma, 140, 997
Myositis ossificans, 348, 588
Myxœdema, 549, 758, 761
Myxo-lipoma, 144
Myxoma, 136
Myxo-sarcoma, 137

Nævo-lipoma, 302
Nævus, 151, 300
    of lip, 662
    of scalp, 642
    of tongue, 705
    of umbilicus, 836
Nails. See Onychia
Nasal bone, fracture of, 378
    septum, fracture of, 378
Naso-pharynx, diseases of, 692
Neck, affections of (Chapter XXVI.), 748-762
    tumours of, 754
Necrosis, acute, 524
    of bone, 374, 519, 522, 524, 529, 538, 539
    of jaw, 667
    of ossicles, 741
    of palate, 724
    of temporal bone, 741
    quiet, 587
Needles, 183
Nélaton's operation on the naso-pharynx, 694

Nephrectomy, 991, 1000
Nephrorrhaphy, 983, 1001
Nephrotomy, 991, 999
Nerve extraction, 326
    grafting, 322
    stretching, 326
    suture, 321, 322
Nerves, affections of special, 326-343
    bulbous ends of, 319
    injuries of, 318
Neuralgia, 252, 324
    of joints, 588
    of testis, 1088
    trigeminal, 327
Neurasthenia, traumatic, 511
Neurectomy, 325
Neuritis, 323
Neuroma, 149
Neurotomy, 325
Nipple, affections of, 791
Nitrous oxide gas, 1140
Nodes, 55, 531, 533, 537
Noma. See Cancrum oris
Nose, affections of (Chapter XXIII.), 681-698

Obstructed hernia, 928
Obstruction, intestinal (Chapter XXXII.), 942-957
Obturator hernia, 927
Obturators for palate, 723
Occipital artery, compression of, 225
    lobe, injuries of, 493
Odontomata, 151, 165, 670, 675, 676
O'Dwyer's tube, 754
Œdema, malignant, 77
    of glottis, 97, 100, 382, 710, 731, 732, 752, 767
    of scrotum, 1091
Œsophagus, affections of, 731
Ogston's operation for flat-foot, 637
        of osteotomy, 624
Olecranon, fracture of, 395
Olfactory nerve, affections of, 326
Omental adhesions, 944
    hernia, 908, 919
Onychia, 189
Oöphorectomy for osteo-malacia, 546
    in cancer of breast, 811
Operations, general antiseptic methods for, 199
    general remarks on abdominal, 901
Ophthalmoplegia externa, 327
Opisthotonos, 113
Optic nerve, affections of, 326
    neuritis, 96, 327, 649, 651, 744, 747
Orbital cellulitis, 96
Orchitis, 1073
Os calcis, fracture of, 427
        tubercular disease of, 535
    incisivum, 653, 658
    magnum, dislocation of, 446
Ossicles, necrosis of, 741
Osteitis, 519, 521
    deformans, 546, 614, 646
Osteitis, tubercular, 533
Osteo-aneurism, 554
Osteo-arthritis, 562, 578, 579, 585, 587, 589, 678
    of hip, 583
    of spine, 830
    of temporo-maxillary joint, 583, 678
Osteo-arthropathy, hypertrophic pulmonary, 549
Osteoblasts, 578
Osteo-chondritis, syphilitic, 540
Osteoclasia, 378
Osteoclasts, 520
Osteoma, 146
    of antrum, 670
    of lower jaw, 675
    of skull, 647
    of upper jaw, 670
Osteo-malacia, 545, 614
Osteo-myelitis, 181, 524, 531
    gummatous, 539
    of cranium, 646
    of spine, 816
Osteo-periostitis, chronic, 531
Osteoplastic section of upper jaw, 694
Osteophytes, 566, 570, 578, 580, 584, 589, 592, 830
Osteo-sarcoma. See Sarcoma of bone, 550
Osteotomy, 544, 624
    for ankylosis, 590, 591, 626
    for genu valgum, 624
    linear, 532
Otorrhœa, chronic, surgical complications of, 740
Ovarian cysts, 166, 167
    dermoids, 165
Oxalates, 1019, 1025
Oxaluria, 1020
Ozæna, 687

Pachydermatocele, 145
Pachymeningitis, 484
Paget's eczema of nipple, 133, 156, 792, 804
Pain in burns, 84
    in gangrene, 67, 69, 73
    in inflammations, 15
    in Pott's disease, 819
Painful scar, 150, 198
    stump, 1125
    subcutaneous nodule, 145
Palate, cleft, 717
    diseases of, 723
Palmar abscess, 42, 191
    arch, hæmorrhage from, 233
    ganglion, compound, 350
Pancreas, affections of, 899
Panophthalmitis, following cellulitis of orbit, 96
Panostitis, 524
Papilloma, 152
    of bladder, 1012
    of breast, 802
    of kidney, 997

Papilloma of larynx, 768
  of nipple, 792
  of rectum, 968
  of scalp, 643, 705
Paracentesis abdominis, 841
Paralysis, infantile, 607, 625, 627-629, 631, 831
  of gut, 839, 897, 937, 943, 946, 947
  of larynx. See Laryngeal paralysis
Paraphimosis, 1065
Paraplegia, 513
  bedsores in, 76
  gravitation, 510
  in Pott's disease, 823
Parasitic cysts, 170
Parenchymatous goitre, 756
  inflammation, 27
Paronychia, 189, 190
Parotid gland, affections of, 711
Parovarian cysts, 166
Parrot's nodes, 540
Pasteur's treatment of hydrophobia, 117
Patella, dislocation of, 453
  fractures of, 416
Pathogenic bacteria, 23, 92
Pelvic cellulitis, 97, 1006, 1014, 1035
Pelvis, fractures of, 402
Penis, affections of, 1063
Perforating ulcer of duodenum, 85, 855
  of foot, 61
Perforation of appendix, 884, 885
  of gastric ulcer, 844
  of intestine, 859
Perforations of palate, 723
Pericardial effusion, 787
Perineal abscess, 1060
  cystotomy, 1006, 1010, 1015
  fistula, 1039, 1046, 1053, 1063
  section, 1059
Perinephritic abscess, 986, 987, 989, 993, 825
Perinephritis, 986
Periosteal sarcoma, 551
Periostitis, acute, 522
  albuminosa, 525
  chronic, 531, 532, 537
  tubercular, 532
Peritonitis, 837, 833, 835, 855, 892, 895, 938, 951, 989
  tubercular, 841
Perityphlitis, 881
Peroneal artery, ligature of, 289
Peronei, tenotomy of, 353
Peroneus longus, dislocation of tendon of, 345
Pes cavus, 637
Petechiæ, 105, 211
Phagedena, 54, 1104
Phagedenic ulcers, 54, 1104
Phagocytosis, 25
Phalanges, amputation of, 1125
  dislocation of, 447
  excision of head of, 640
  fractures of, 402
Phantom tumour, 836
Pharyngotomy, subhyoid, 769
Pharynx, affections of, 728
Phelps's box, 827
  operation (talipes), 634
Phimosis, 1015, 1063
Phlebitis, 107, 295
Phleboliths, 292, 298
Phlegmonous inflammation, 27, 93
Phosphates in urine, 545, 1020, 1026
Phosphorus necrosis of jaw, 667
Phrenic nerve, injury to, 336
Picric acid in treatment of burns, 87
Pigeon breast, 542
Piles, 973
Pirogoff's amputation, 1133
Pistol splint, 401
Plantar arch, hæmorrhage from, 233
Plastic surgery (Chapter XXXIX.), 1117-1120
Pleurosthotonus, 113
Plexiform angioma, 151, 642
  neuroma, 150
  sarcoma, 142
Pneumectomy, 786
Pneumatocele, 782
Pneumogastric nerve, affections of, 335
Pneumothorax, 779
Pneumotomy, 786
Poisoned wounds, 187
Polydactylism, 616
Polypus of antrum, 670
  of ear, 741
  of nose, 689
  of rectum, 968, 1015
  of umbilicus, 836
  of urethra, 1041, 1051
Pons Varolii, injuries to, 494
Popliteal aneurism, 271
  artery, ligature of, 287
Post-mortem wounds, 188
Pott's disease, 816
  fracture, 424
  puffy tumour, 17, 484
Priapism, 509, 511, 515, 1043
Primary arterial hæmorrhage, 223
  union of wounds, 194
Proctectomy, 970
Proctitis, 960, 1097
Prolapse of anus, 979
  of intestine, 835, 881
  of lung, 783
  of rectum, 979
Prostate, affections of, 1038
  senile enlargement of, 272, 284, 1041
Protozoa, 21
Pseud-arthrosis, 375
Pseud-elephantiasis, 307
Pseudo-neuroma, 145, 149
Pseudo-paralysis, syphilitic, 540
Psoas abscess, 42, 44, 823, 826, 923
Psoriasis linguæ, 703
  syphilitic, 1108
Psorosperms, 22, 133, 155, 792
Ptomaines, 23, 90
Ptosis, 327

Pubic dislocation of hip, 452
Pudic artery, hæmorrhage from, 233, 1034
    ligature of, 285
Pulpy disease of synovial membrane, 568
Pulsating exophthalmos, 266
  tumours of bone, 554
    of scalp, 642
Punctured fracture of skull, 467
  wounds, 182
    of chest, 780
    of heart, 787
    of intestine, 858
Pus in acute abscess, 40
  in chronic abscess, 44
  in hepatic abscess, 892
Pustule. See Malignant pustule
Pyæmia, 27, 93, 97, 102, 105, 106, 108, 181, 292, 293, 374, 527, 529, 561, 641, 651, 712, 891, 976
Pyæmic joints, 561
Pyelitis, 985
Pylephlebitis, 108, 293, 885, 891, 976
Pylorus, affections of, 850
  operations on, 852
Pyogenic membrane, 45
  organisms, 36
Pyonephrosis, 989, 993
Pyorrhœa alveolaris, 666
Pyrexia. See Fever
Pyuria, 1022

Quilled suture, 177
Quincke's lumbar puncture, 486
Quinsy, 725

Rabies, 116
Radial artery, compression of, 225
    ligature of, 282
Radical cure of hernia, 917, 924, 925, 937
  of hydrocele, 1084
Radius, congenital absence of, 616
  dislocations of, 445
  fracture of, 397
Railway spine, 511
Ranula, 705, 710, 749
Rarefaction of bone, 518, 520
Rashes of syphilis, 1105
Ray fungus, 131
Raynaud's disease, 70
Reaction, 204, 478
Reactionary hæmorrhage, 227
Recto-vaginal septum, wound of, 1068
  vesical fistula, 1014, 1035, 1091
Rectum, affections of (Chapter XXXIII.), 958-981
Rectus abdominis, injuries of, 834
Recurrent dislocations, 432, 436, 622
  fibroid, 140, 803
  hæmorrhage, 227
Redness in inflammation, 16
Regeneration of nerves, 321
Reid's lines, 496, 747
Repair of bone after caries, 521, 818, 820
    after fractures, 366, 374
    after necrosis, 523, 527
Repair of muscle, 345
  of tendon, 345, 352
  of wounds, 191
Resection. See Excision
Respiration, artificial, 790
Retained testis, 1069
Retention cysts, 168
  of urine, 1017, 1043
Retro-peritoneal abscess, 885
  pharyngeal abscess, 42, 731, 822
Rhabdomyoma, 149
Rhagades, 1115
Rheumatic arthritis, 563, 566
  gout. See Osteo-arthritis, 579
  spondilitis, 830
  synovitis, 559
Rheumatoid arthritis. See Osteo-arthritis, 579
Rhinitis, 685, 1097
Rhinophyma, 682
Rhinoplasty, 682
Rhinoscopy, 684
Ribs, fracture of, 382
Richter's hernia, 929, 957
Rickets, 541, 609, 614, 620, 621, 625, 646
Rigg's disease, 666
Rigor, 39
Robson's (Mayo) bobbin, 874
Rodent ulcer, 61, 158, 682
Rontgen X rays, 183
Rouge's operation, 693
Round-celled sarcoma, 138
Rupia, 60, 1108
Rupture. See Hernia
Rupture of aneurism, 252
  of bladder, 1004
  of gall-bladder, 895
  of intestine, 857
  of liver, 890
  of main artery, 235
  of muscles, 344, 345
  of rectus abdominis, 836
  of spleen, 900
  of stomach, 842
  of urethra, 403, 1049, 1062

Sacculated aneurism, 248
Sacral tumour, congenital, 815
Sacro-iliac disease, 597
Sacrum, fractures of, 404
Salivary calculus, 710, 712
  fistula, 713, 716
  glands, affections of, 711
Salivation in cancer of tongue, 705
  in mercurialism, 1112
Saphena, varix of, 298, 924
Sapræmia, 91, 105, 526, 529, 565
Sarcoma, 137-143
  curative action of erysipelas on, 102, 143
  of bladder, 1013
  of bone, 550
  of brain, 649
  of breast, 802
  of cranium, 647

- Sarcoma of jaws, 667, 671, 676
  - of kidney, 997
  - of lymphatic glands, 139, 316
  - of muscle, 348
  - of naso-pharynx, 692, 693
  - of nose, 692, 693
  - of palate, 724
  - of parotid, 713
  - of rectum, 968
  - of scalp, 642
  - of skull, 647
  - of spine, 831
  - of testis, 1080
  - of thyroid, 761
  - of tonsil, 727
- Scalds, 84
- Scalp, affections of, 641
  - injuries of, 460
- Scapula, fractures of, 387
  - winged, 336, 439
- Scar, affections of, 197
- Schede's operation, 785
- Sciatica, 341, 598
- Sciatic artery, hæmorrhage from, 233
    - ligature of, 285
  - dislocation of hip, 450
  - nerve, stretching of, 342
- Scirrhous ulcer. See Ulcer, 61
- Scirrhus, 161
  - of breast, 804, 806
  - of pancreas, 900
  - of prostate, 1047
  - of pylorus, 851
- Sclerosis of bone, 520, 537
- Sclerotitis, gonorrhœal, 1098
- Scoliosis, 609
- Scorbutic ulcer, 62
- Scrotal tumours, 1088
- Scrotum, affections of, 1091
- Scurvy rickets, 544
- Sebaceous cysts, 168
  - of neck, 751
  - of nipple, 792
  - of scalp, 643
- Sebaceous glands, cancer of. See Rodent ulcer
  - horn, 168, 1066
- Secondary hæmorrhage, 227
- Semilunar cartilage, dislocation of, 455, 587
- Semimembranosus, tenotomy of, 353
- Senile atrophy of bone, 358, 405, 645
  - gangrene, 72
  - hypertrophy of prostate, 1041
  - tuberculosis, 120
- Senn's plates, 875
- Sepsis, 89-92
  - in treatment of chronic abscess, 45
  - secondary hæmorrhage with, 227
- Septic arthritis, 90, 563
  - intoxication, 91
  - meningitis. See Meningitis
  - osteo-myelitis. See Osteo-myelitis
  - peritonitis. See Peritonitis
- Septic pneumonia, 79, 708, 709, 735, 765, 776, 780
  - traumatic fever, 90
- Septicæmia, 93, 103
- Septum nasi, fracture of, 378
    - lateral deviation of, 687
- Sequestra, 519
- Sequestration dermoids, 164
- Sequestrotomy, 528
- Serous cysts, 168, 751
  - synovitis, chronic, 561, 562
- Seventh nerve. See Facial nerve
- Shock, 202
  - from amputations, 1124
  - from catheterism, 1055
  - during anæsthesia, 205, 1144
  - in abdominal surgery, 833, 834, 842, 844, 848, 856-858, 890, 895, 900, 902
  - in burns, 85
  - in intestinal obstruction, 931, 943, 956
- Shoulder-joint, acute arthritis of, 567
  - amputation through, 1128
  - ankylosis of, 589
  - dislocation of, 439
  - effusion into, 557
  - excision of, 600
  - tubercular disease of, 575
- Sinus, 49
- Sixth nerve, affections of, 333
- Skin grafting, 59, 682, 1117
- Skull, affections of, 643
  - injuries to, 461
- Sloughing ulcers, 53
- Smith's (Stephen) amputation, 1134
- Snake-bites, 187
- Socin's operation, 760
- Soft chancre, 1099
- Sounding bladder, 1027
- Spasm of œsophagus, 734
- Spasmodic stricture of urethra, 1051
- Spence's operation, 1128
- Spermatic cord, hæmatocele of, 1072
  - hydrocele of, 1085
  - torsion of, 1070
- Spermatocele, 1084
- Spina bifida, 627, 812
    - occulta, 815
  - ventosa. See Tubercular dactylitis, 533
- Spinal accessory nerve, affections of, 335
    - stretching of, 335, 608
- Spinal-cord, diseases of, 831
  - injuries of, 508-515
  - pressure on, in Pott's disease, 823, 829
  - total transverse lesion of, 51
- Spine, deformities of, 609-616
  - diseases of (Chapter XXIX.), 812-832
  - injuries to (Chapter XVII.), 499-516
- Splay-foot. See Flat-foot
- Spleen, affections of, 900
- Splint pressure causing gangrene, 76
- Splints, uses of, 369

Spondylitis, rheumatic, 830
Spondylo-listhesis, 616
Sponges, method of purifying, 199
Spongy gums, 665, 700, 1112
Spontaneous fracture, 251, 358, 548, 551
Sprains, 344, 428, 500
Spreading gangrene, acute, 77
Stabs, 182
Staphylococci, 22, 36, 80, 94, 106, 524, 529, 564
Staphylorraphy, 722
Stercoral ulcers, 930, 965, 970
Sterno-mastoid, action of, in torticollis, 606
    congenital induration of, 749
    tenotomy of, 608
Sternum, fractures of, 384
Stings, 187
Stomach, affections of, 842
Stomatitis, 699
    mercurial, 1112
Stone. See Calculus.
Strain, 235, 247, 318, 344, 428
Strangulated hernia, 928-941
Strangulation, causing gangrene, 75
    internal, 943
Strangury, 990, 1008
Streptococci, 22, 36, 94, 97, 98, 104, 106, 143, 525, 529, 564, 837
Stricture of appendix, 882, 886
    of bile duct, 898
    of intestine, 861, 949, 954
    of œsophagus, 734
    of pylorus, 850
    of rectum, 965
    of urethra, 1051
Stumps (amputation), affections of, 1124
Styptics, 218
Subaponeurotic abscess, 641
    hæmatoma, 461
Subastragaloid amputation, 1132
    dislocation, 458
Subclavian artery, aneurism of, 266
    compression of, 225
    ligature of, 267, 279
Subclavicular dislocation of the shoulder, 441
Subcoracoid dislocation of the shoulder, 441
Subcranial abscess, 483, 651, 743
    inflammation, 483
Subdeltoid bursa, affections of, 356, 557
Subglenoid dislocation of the shoulder, 440
Sublingual abscess, 97, 710
Subluxation of head of radius, 446
    of knee, 455
Submammary abscess, 96, 793, 796
Submaxillary cellulitis, 96, 710
Subphrenic abscess, 844, 855
Sebserous lipoma, 144, 926
Subspinous dislocation of the shoulder, 442
Subungual exostosis, 147
Superior maxilla, affections of, 665, 668, 670
Superior maxilla, excision of, 672
    fracture of, 379
Suppression of urine, 995, 1024, 1056
Suppuration (Chapter II.), 34-51
Supracondyloid amputation of thigh, 1135
Supra-orbital nerve, operations on, 329
Suprapubic aspiration, 1059
    cystotomy, 1011, 1036
    puncture for enlarged prostate, 1046
Supratrochlear nerve, operations on, 329
Surgical kidney, 994, 1009, 1031, 1043
Sutures, 176
    intestinal, 864
Sylvester's method of artificial respiration, 790
Syme's amputation, 577, 1132
    horseshoe splint, 427
    operation for restoration of lip, 664
        of urethrotomy, 1057
    treatment of chronic ulcers, 57
Symonds' tube, 736, 737
Sympathetic nerves, affections of, 262, 268, 343, 760
        in shock, action of, 203, 833, 956
Syncope, 204, 1144
Syndactylism, 618
Synovial membrane, hypertrophy of fringes of, 580, 586
    pulpy disease of, 568
Synovitis, acute, 556, 678
    chronic, 561
    gonorrhœal, 561, 1098
    syphilitic, 578
Syphilis, 93, 119, 1100
Syphilitic affections of anus, 966
        of arteries, 241, 243, 244, 247, 1108, 1109
        of bone, 529, 531, 537, 627
        of breast, 792, 797
        of bursæ, 355
        of cranium, 538, 646, 647
        of epididymis, 1109
        of intestine, 861, 956
        of joints, 562, 578
        of larynx, 767
        of lip, 660, 661
        of lymphatic glands, 311
        of meninges, 487, 649
        of muscles, 348
        of nerves, 318, 324, 327, 354
        of nose, 681, 687, 689
        of palate, 723
        of pharynx, 730
        of rectum, 966
        of spine, 500, 830, 831
        of testis, 1077, 1109
        of tongue, 702, 704
        of tonsil, 727
    ulcers, 60, 1110
Syringo-myelocele, 812

Tagliacozzian operation, 683
Talipes, 627, 814, 831
Tarsal cyst, 652

- Tarsectomy, 634
- Tarsus, amputation of, 1131
- Taxis, 933
- Teale's amputation, 1123, 1134
- Teeth in congenital syphilis, 1115
  - in rickets, 541
  - tumours in connection with. See Odontomata
- Temporal artery, compression of, 225
  - ligature of, 279
- Temporo-maxillary joint, diseases of, 583, 678, 741
  - injuries of, 436
- Tendo Achillis, rupture of, 346
  - tenotomy of, 352
- Tendon sheaths in hand, 190
- Tendons, injury to, 344
- Teno-synovitis, 348
- Tenotomy, 351, 633, 832
  - of sterno-mastoid, 608
- Testicle, affections of (Chapter XXXVII.), 1069-1088. See also 915, 923, 938
- Tetanus, 93, 111, 181
  - neonatorum, 836
- Thecal whitlow, 190
- Thiersch's method of skin-grafting, 59, 88, 1119
  - of nerve extraction, 326
- Thigh, amputation of, 1136
- Third nerve, affections of, 327
- Thomas's hip-splint, 596
  - knee-splint, 576
- Thoracic duct, wound of, 307
- Thorax, deformities of, in rickets, 542
  - punctured wounds of, 781
- Thrombosis, arterial, 72, 74, 235, 246
  - of cerebral sinuses, 107, 266, 488, 642, 689, 744
  - of lateral sinus, 107, 488, 744
  - venous, 107, 290, 976
- Thrush, 699
- Thumb, amputation of, 1126
  - dislocation of, 447
- Thyroid body, diseases of, 755
- Thyroid dislocation of hip, 451
- Thyroid vessels, ligature of, 280
- Thyro-glossal duct. See Cyst of, 165, 705, 716, 749
- Thyrotomy, 769
- Tibia, fracture of 422
  - rachitic, 543, 626
  - syphilitic, 540, 627
- Tibial arteries, compression of, 226
    - ligature of, 287, 288
  - nerves, affections of, 343
- Tic douloureux, or epileptiform tic, 327, 328
- Toes, amputation of, 1129
  - deformities of, 637-640
- Tongue, affections of, 700-710
- Tonsil, affections of, 725
- Topography, cerebral, 495
- Torsion, 220
- Torticollis, 606
- Tourniquets, 226
- Toxins, 23
- Trachea, foreign bodies in, 764
  - wounds of, 752
- Tracheal tug, 261, 264
- Tracheotomy, 772
  - in affections of larynx, 103, 731, 764, 765, 766, 767, 768
  - preliminary, 673, 708, 731, 737
- Traumatic aneurism, 236
  - delirium, 207, 363
  - epilepsy, 497
  - fever, 90, 206, 363
  - gangrene, 74, 77. See Gangrene
  - neuroma, 150
- Transfusion, 212
- Transillumination of antrum, 669
- Trendelenburg's position, 1036
  - trachea tampon, 708, 774
- Trephining, 472, 475, 477, 484, 491, 498, 649, 651
- Trigeminal neuralgia, 327
- Trismus, 113, 132, 679
- Trochanter, fracture of, 412
- Tropical abscess of liver, 891
- Trusses, 916
- Tubercular abscess, 43, 93
    - results of sepsis in, 44, 45
  - disease of bladder, 1011
    - of bone, 532
    - of breast, 796
    - of bursæ, 355
    - of epididymis, 1075
    - of hip-joint, 591
    - of joints, 568
    - of kidney, 986
    - of larynx, 767
    - of lymphatic glands, 312
    - of mucous membrane, 128
    - of peritoneum, 837, 841, 860
    - of prostate, 1040
    - of sacro-iliac joint, 597
    - of skin, 123
    - of spine, 816
    - of temporo-maxillary joint, 679
    - of testis, 1075
    - of tongue, 704
    - of vesiculæ seminales, 1091
  - empyema, 784
  - endarteritis, 121, 244
  - ischio-rectal abscess, 961
  - leprosy, 129
  - lupus, 123
  - ulcers, 60, 127
- Tuberculosis, 119
- Tubulo-dermoids, 165
- Tumour, congenital sacral, 815
  - Pott's puffy, 17, 484
- Tumours, 133-164
  - of adrenals, 997
  - of antrum, 670
  - of bladder, 1012
  - of bone, 550
  - of brain, 648
  - of breast, 798
  - of cranium, 647

Tumours of gum, 666
  of intestine, 862, 968
  of kidney, 995
  of larynx, 768
  of lip, 662
  of liver, 895
  of lymphatic glands, 314
  of mandible, 675
  of maxilla, 670
  of muscle, 348
  of neck, 734
  of nose, 682, 689
  of œsophagus, 734
  of palate, 724
  of pancreas, 900
  of parotid, 713
  of penis, 1066
  of pharynx, 730
  of prostate, 1041, 1047
  of rectum, 968
  of scalp, 642
  of spine, 831
  of spleen, 900
  of sub-maxillary gland, 715
  of testis, 1079
  of thyroid gland, 735
  of tongue, 705
  of tonsil, 727
  of urethra, 1051
Typhoid necrosis, 515
  state, 19
  ulcer, perforation of, 860
Typhlitis. See Appendicitis

Ulceration (Chapter III.), 52-62
Ulcer of anus, 964, 967, 968
  of bladder, 1011
  of intestine, 85, 843, 859, 861, 934
  of palate, 723
  of scars, 198
  of stomach, 855
  of tongue, 703
Ulcers, perforating, of duodenum, 85, 843
    of foot, 61
  phagedenic, 54, 1104
  scirrhous, 61, 806
  scorbutic, 62
  tubercular, 60, 127, 704, 723
Ulna, dislocation of, 443, 444
  fracture of, 395
Ulnar artery, compression of, 225
    ligature of, 282
  nerve, affections of, 340
Umbilical hernia, 924
Umbilicus, affections of, 836
Un-united fracture, 375
Uranoplasty, 721
Ureter, rupture of, 984
Urethra, affections of, 1048
Urethral fever, 995, 1056
Urethrotomy, 1057
Uric acid and urates, 1018, 1025
Urine, abnormalities of, 1018
Uvula, elongation of, 724

Varicocele, 297, 997, 998, 1086
Varicose aneurism, 240
  eczema, 298
  ulcers, 56, 298
  veins, 292, 297, 299, 734, 924, 973, 1086
Varix, 297, 734, 924
Vasectomy, 1046
Veins, affections of (Chapter X.), 290-304
  entrance of air into, 230, 474, 752, 775
Venesection, 302
Venous hæmorrhage, 230
  sinuses, thrombosis of. See Thrombosis of
    wounds of, 473
Ventral hernia, 889, 926
Vermiform appendix. See Appendicitis
Vertebral artery, hæmorrhage from, 232
  ligature of, 267, 280
Vesical calculus. See Calculus
  fistula. See Fistula
Vesiculæ seminales, affections of, 1091
Vicious union of fractures, 378
Villous tumour of bladder, 153, 1012
    of intestine, 153, 968
    of pelvis of kidney, 153, 997
Vocal cords, paralysis of. See Laryngeal paralysis
Volvulus, 944
Vomiting after concussion, 478
  after shock, 204
  anæsthetic, 1143
  cerebral, 649, 651
  fæcal, 931, 943, 956
  in cholecystitis, 897
  in intestinal obstruction, 943, 956
  in peritonitis, 838
  in strangulated hernia, 931, 932, 956
  persistent, after taxis, 934
  with moveable kidney, 983
Vulva, affections of, 1068

Wagstaffe's fracture, 422
Wardrop's operation for aneurism, 257, 263
Warts. See Papilloma, 153
  anatomical, or butchers', 188
  malignant, 156
  of umbilicus, 836
  on lip, 663
  venereal, 1066
Wax in ear, 739
Webbed fingers, 618
Whitehead's operation on hæmorrhoids, 979
    on tongue, 707
White swelling, 568
Whitlow, 190
Wolffian body, cysts of, 165, 1085
Wölfler suture, 865
Wool-sorter's disease, 117, 119
Wounds (Chapter VII.), 173-189
  of abdominal walls, 834
  of air passages, 765

Wounds of arteries, 235
  of bladder, 1004
  of brain, 477
  of gall bladder, 895
  of heart, 789
  of intestine, 857
  of joints, 428
  of kidney, 983
  of larynx, 765
  of liver, 890
  of lung, 778
  of muscles, 344
  of nerves, 318
  of pancreas, 899
  of scalp, 460
  of scrotum, 1091
  of spine, 501
  of spleen, 900
  of stomach, 842
  of testis, 1071
Wounds of throat, 751
  of tongue, 701
  of trachea, 751
  of ureter, 984
  of urethra, 1049
  of veins, 230, 473
  of vulva, 1068
Wrist-drop, 337
Wrist-joint, acute arthritis of, 567
  amputation at, 1126
  ankylosis of, 590
  dislocation at, 446
  effusion into, 557
  excision of, 602
  tubercular disease of, 575
Wry-neck. See Torticollis

Xanthine, 1026

Zygoma, fracture of, 379

THE END.

Baillière, Tindall and Cox, King William Street, Strand.

567